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DISCOVERY

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YANGI HISSAR IN CHINESE TURKISTAN
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Editorial Notes.

The question of immortality of the soul has again been publicly discussed, following some remarks of Sir Arthur Keith at the University of Manchester. In his presidential address last summer to the British Association, on the modern position of Darwinism, he was careful to avoid metaphysical implications, but the new challenge leaves no doubt of its author's views. "Every fact known to medical men," Sir Arthur said, "compels the inference that mind, spirit, soul are the manifestations of a living brain, just as flame is the manifest spirit of a burning candle. At the moment of extinction both flame and spirit cease to have a separate existence." Sir John Bland-Sutton came to his support with the lines of a poem, which concludes:—

> Youth often laughs at death, but old men weep,
> Wise men know death to be an endless sleep.

The opposing view was at once expressed by Sir Oliver Lodge, who compared the brain to a musical instrument and the mind directing the brain to the music—"the real thing behind the scenes." As, however, we cannot measure such factors in terms of physical science, the controversy has little intrinsic value; its more serious aspect is the effect on the general public. Credit is due to Sir Arthur Keith for speaking his mind, but there is every ground for Mr. Alfred Noyes's criticism, that he has attacked on insufficient evidence one of the keystones of a great religious faith, affecting the innermost life of millions of people; and that further, coming from a Fellow of the Royal Society, such dogmatic sentences may affect the claim of science to speak with authority. We may add that they also help to justify, at the other extreme, dogmatic theological assertions for which the evidence is equally uncertain.

* * * * *

While our May number was in the press, Captain G. H. Wilkins made a successful flight of two thousand miles across the Arctic Ocean, thus following closely the Atlantic east-to-west record of a few days previously. The course taken, from Point Barrow, Alaska, to Spitsbergen, did not actually pass over the North Pole, and considerable belts of cloud interfered at times with observation. Captain Wilkins was accompanied by Mr. C. B. Eielson. No landing was attempted in the polar region, but they were forced to come down on the shore of Ice Fjord owing to difficulty in finding King's Bay, their intended destination. Four days were spent in the grounded machine, after which the airmen appear to have had considerable adventures in getting it off again, to complete the journey. During the first part of the flight they had crossed the unexplored Beaufort Sea.

* * * * *

Further news of Nova Pictoris, which recently became double, indicates that the star now appears as an elongated nebulous mass, divided into four portions. It is surrounded by three rings, the outer one three minutes in diameter. There are two possibilities about these rings. If they are of similar nature to the nebulous ring round Nova Persei in the autumn of 1901, they give a distance of several thousand light-years for Nova Pictoris. If they are due to the actual expulsion of the outer layers of the star, its distance must be very moderate, only some forty light-years. It is stated from Johannesburg that the rings are increasing in diameter a second a day, and we may hope that the next few months will enable their true nature to be determined. The star has been put down for careful observation of parallax. If it is really at the small distance, the theory of the collision of two stars must be abandoned, for there would

in that case be much greater proper motion than that of one and a quarter seconds in twenty-four years.

* * * * *

A recent article by the scientific correspondent of *The Times* dealt at length with the bird migration theories first advanced by Commander Acworth in *Discovery*. Some fair and interesting comments were made on his views, but as no reference was given to their original source, it may be well to remark on certain points arising out of the article. We do not necessarily endorse our contributor's case, but at least it should be read in full if *The Times*' criticism is to be of serious value. Remarking that "the wind may blow as it listeth" but the migratory birds keep their appointments year by year, the critic suggests that it "may be" that the appointments have been fixed with reference to more or less constant streams of air. Commander Acworth, however, made his view quite clear that migrations in general follow such wind streams, not because the bird *reasons* to take advantage of their aid, but because it can do no other than move with them, flight being a single medium operation. In consequence, the speed of a bird which attempts to fly against a contrary wind will be dependent on its force, and the main wind streams are probably too strong to permit competition. The most powerful aeroplane or airship is subject to exactly the same factors; we may recall the case of the R 33, which left England with ample fuel supplies, but had only the barest margin by the time it reached New York.

* * * * *

Two pre-Viking ships and an ancient oar have just been found in Sweden by local archaeologists. The oar, made for paddling, was buried in a deep bog in Dalecarlia, and an expert has fixed its age at approximately five thousand years. A new method called the "pollen" test was employed; this consists in examining a piece of the soil where the object has been found and where pollen abounds. Geologists have drawn up immigration maps for various plants, fixing the age of their existence in Sweden. On this occasion they found no pine pollen in the clod examined, and knowing that the pine entered Dalecarlia some time after 3,000 B.C., they accordingly dated the oar as belonging to an earlier period. This "pollen" analysis, discovered by the Swedish botanist, the late Dr. Lagerheim, is looked upon as a revolutionary method of dating such finds.

* * * * *

Glasgow will this year be the centre for the annual meeting of the British Association, to be held from 5th-12th September. Sir William Bragg will preside, and is expected in his address to deal with modern developments in physics and their relation to national problems. Of kindred interest is a paper by Sir William Ellis, on the influence of engineering on civilization. Another practical problem, to be discussed by Sir John Reith, is wireless in the service of education—a subject, incidentally, which is dealt with in Sir Henry Hadow's new report. (See our review, page 202.) Two evening lectures will, as usual, be given in the course of the week, one under the title the Mystery of Life (Professor F. G. Donnan), the other on the study of popular sayings (Professor Westermarck). The meetings will be held in the university buildings, while practical study is offered by the many industries of the Clyde area.

* * * * *

Following the installation in Washington of an acoustical device for regulating the water supply, another American city has gone one better by installing an automatic policeman! Red and green electric lights are widely used in America as traffic signs at cross roads, and hitherto the colour has been changed by human operation—in the case of Fifth Avenue in New York, for example, a chain of lights covering many cross streets is regulated from central conning towers. The Baltimore device replaces this operation by a microphone, which is fixed on a post facing the side street. Normally the lights are set so as to show green along the main thoroughfare and red down the side, but in response to the sound of a motor horn the microphone reverses the colours; after an interval of some seconds these automatically resume their normal setting. In the meantime the car has emerged safely from the side street. During the three months since the automatic policeman was installed, the microphone is reported to have worked exactly to plan. Strange to say, it seems even to have escaped the attention of mischievious children.

* * * * *

We shall shortly publish an article on experiments in the rocket propulsion of an aeroplane, which are to be undertaken in Germany. Readers will recall that a year ago we discussed some plans for a rocket ship that might cross the Atlantic in two hours, and the new experiments will be described by the same contributor, Herr Max Valier. According to advance particulars, a light aeroplane weighing only 550 lb. is to be used, driven by two batteries of rockets situated on either of the fuselage, and it will be brought to rest by gliding after the power is discharged. A racing motor-car employing similar principles has already been constructed at the Opel works in Berlin, for an attempt at a world's speed record.

The Life-Histories of Pea-Crabs.

By Marie V. Lebour, D.Sc., F.Z.S.

Naturalist at the Plymouth Marine Laboratory.

New facts have been discovered about these small crabs which live happily inside bivalve molluscs. The larval stages in their life-histories, differing widely in the two British species, are now easily recognizable.

LAST October I gave an account of the larval stages of a spider crab, and further research at Plymouth has now shown us the larvae of two pea-crabs. The first zoea or first larval stage of the common pea-crab, *Pinnotheres pisum*, is one of the earliest crab larvae known, for in 1835 E. V. Thompson, one of the keenest naturalists of his time, who discovered the true nature of the crab zoea, hatched them out from the eggs carried by the crab. Previously all zoeae had been considered as separate species and not larval forms. Very little has been added to our knowledge of this particular zoea up to the present time, and the only existing figures were those given by Thompson himself.

Pea-crabs are specially interesting and have been known from very early times when the ancients sang of the "Pinna Guard" and the "Pinna Watcher," attributing fanciful relations between shell and crab, and in old Egyptian inscriptions its presence is said to represent the dependence of man on his friends. Their usual home is in a bivalve shell such as a mussel, horse-mussel, oyster, or cockle. The form to which all the classical allusions refer lives in Pinna, a large wedge-shaped mollusc living buried in sand and mud which is much commoner on the coasts of the Mediterranean than it is with us, although it does occur on our coasts. Some years ago it was found much more frequently, but its rarity now is said to be attributable to the presence of pearls inside it, so that it was eagerly collected. The pearls are, however, of little value, being devoid of the true pearly lustre.

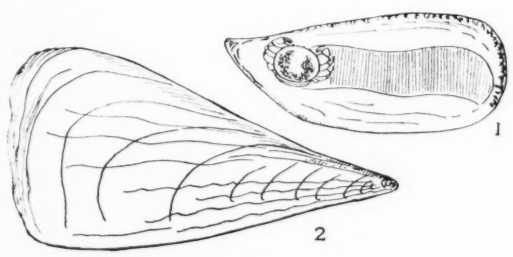


FIG. 1.

COMMON PEA-CRAB IN A MUSSEL, AND PINNA SHELL.

(1) The common pea-crab inside its host, the common mussel (4½ inches long). Half of the mussel has been removed to show the crab in its natural position. (2) Shell of pinna, 9½ inches long, in which the pinna pea-crab is found.

There are thus in Britain two species of pea-crab, one, by far the commoner of the two, is the "common pea-crab" living in the common mussel, occasionally in horse-mussels, oysters, cockles, and sea-squirts, and the "Pinna pea-crab" of the ancients living in Pinna or occasionally in other shells or in sea-squirts.

If we open a mussel, perhaps in five or ten per cent

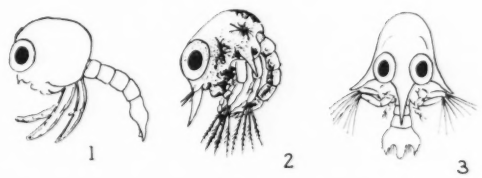


FIG. 2.

LARVAL STAGES OF THE PEA-CRAB.

(1) Pre-zoea of the common pea-crab, which almost directly becomes (2), the first zoea. (3) Is the first zoea from the front, showing its downwardly directed spines and absence of dorsal spine.

in a certain locality will be found a small round crab, perfectly at home when the shell is shut, living on microscopic food brought into the mussel by its currents and doing no harm to its "host," as the mussel is called (Fig. 1). It is the same with any of the other hosts the crab may inhabit. We have here a case of commensalism when two animals live together in a perfectly harmless association. The crab finds shelter and food, and the mussel is apparently not incommoded by its guest. Because it always lives in shelter the outside of the crab, which in free forms is hardened as an armour, is very soft and flexible, especially in the female, whose tail part tucked in under the body is very large and almost covers the eggs when she is "in berry" or bearing the eggs attached to her hind limbs. The male is smaller and not so soft, and sometimes comes outside, although he too is often to be found inside the mussels.

Whilst investigating the life-histories of various crabs at Plymouth, several "berried" females of the common pea-crab, *Pinnotheres pisum*, were taken from local mussels. Those having eggs nearly ready to hatch were placed in aquaria with a shelter of stone or shells, and the free-swimming larvae obtained. As in the spider crab, first came the pre-zoea, which

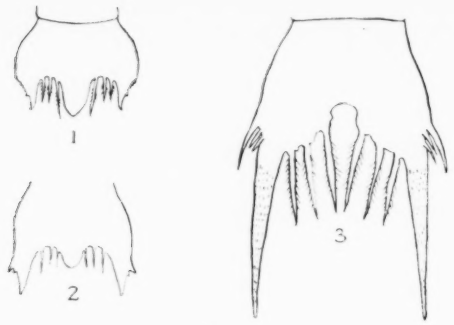


FIG. 3.
TAIL FINS OF PEA-CRABS AND SPIDER CRAB.
Telson of (1) common pea-crab, (2) pinna pea-crab, and (3) spider crab, showing the three lobes in the pea-crabs and fork in the spider crab. By the telson alone a pea-crab may be recognized.

is the first zoea, enclosed in a very delicate embryonic skin, this skin being quickly discarded and the first zoea freed (Fig. 2). A typical crab zoea has four long spines on its body which are mainly for directive purposes and for keeping in the upper water layers. In the spider crab previously described there was only one such long spine, situated dorsally in the middle of the back. The zoea of the common pea-crab has no dorsal spine, but it has one at each side bending down and one bent down in front of the eyes. Thus none of the long body spines stick out so as to present a resisting surface to the water. The reason for this appears to be that the zoea naturally does not live in the upper water layers, but keeps near the bottom. Those living in the aquarium when first hatched rose to the surface, but very soon they seemed naturally to keep near the bottom where they fed on *débris*.

The zoea is extremely small, rather less than a millimetre in length, and has a tendency to curl itself up in a ball with its tail tucked under its body, thus again enabling it to keep down in the water. Like the spider crab it has two pairs of long limbs, each armed with four bristles by means of which it swims, and these limbs eventually change to mouth parts, the true legs at this first zoea stage being mere rudimentary buds. In front are two large eyes and two pairs of feelers, the hind pair being very rudimentary, and three pairs of jaws. The front part of the body as far as the rudimentary legs is covered by a shield, the *carapace*, and behind is a jointed tail, the *abdomen*, which at the end bears a tail fin, the *telson*. The telson in these pea-crabs is peculiarly shaped and unlike that of any other larval crab in having three lobes instead of the usual fork as in the spider crabs (Fig. 3). By the telson alone a pea-crab may be recognized.

It was unfortunately not possible to rear the larvae beyond the first zoea for, although they ate microscopic plants (diatoms) and *débris* in the aquarium, they never changed to a later stage. One later stage was, however, found from plankton taken near the shore, which was probably the second zoeal stage. This was interesting, because the long spines of the carapace were greatly reduced, showing that it was still more of a bottom form. From the rudimentary limbs on the tail, which were very small, it could be seen that this was not the last zoea, and we can thus be certain that the common pea-crab has at least three if not four zoeal stages before changing into the megalopa or last larval stage.

Now the interesting fact about the larvae of the pea-crabs is that they vary very much in the different species, and although Pinna is now so rare about

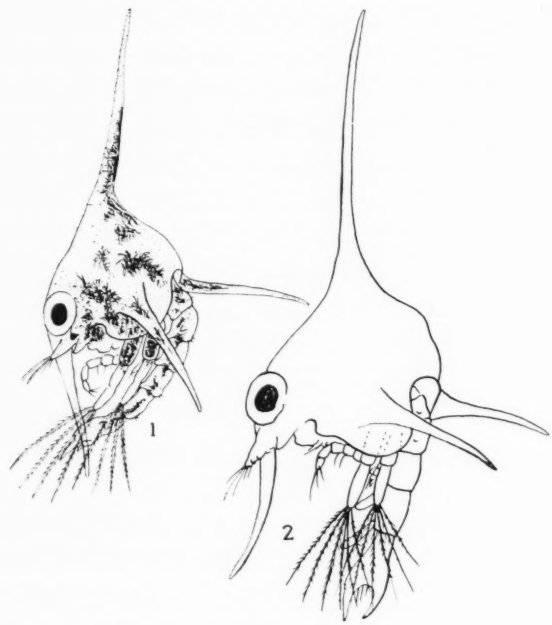


FIG. 4.
THE PINNA PEA-CRAB.
(1) First zoea. (2) Second and last zoea, showing the four long spines on the shield or carapace.

Plymouth that the adult Pinna pea-crab could not be found, yet the larvae were found in the plankton. Further, while these agreed with the common pea-crab in having a three-lobed telson and rudimentary second feelers, they were very unlike in other ways. The Pinna pea-crab, *Pinnotheres veterum*, is in the first place very much larger than the common pea-crab in its zoeae (Fig. 4)—first zoea 1.5 mm. long, second zoea 2 mm.; secondly, they had four long spines

on the carapace, one long dorsal spine, sticking up, one long spine each side bent downwards and outwards, and one long spine bent down between the eyes. The zoea was thus quite well adapted for keeping in the upper waterlayers. The colour is quite different too, brownish and pink instead of yellow and black. Another important difference is that the first zoea is much further advanced and already has rudimentary limbs on the tail. The first zoea kept in an aquarium changed to the second, and this was so far advanced that it was evident that it was the last zoea having long rudimentary tail limbs and the rudimentary legs well advanced. There are six long hairs on the swimming limbs. The second zoea from the plankton changed in the aquarium to the megalopa or last larval stage (Fig. 5). This stage is also free-swimming, but instead of being flattened from side to side like the zoea it is flattened from above downwards. Also, instead of swimming with the hind mouth parts adapted for swimming organs, as in the zoea, these have now taken on their true function as mouth parts and the true legs are fully developed, the swimming being done by the tail limbs which now are armed with long bristles. The megalopa of the Pinna pea-crab is nearly straight in front, and has a smooth carapace without spines. It measures nearly two millimetres in length and closely resembles a true crab, tucking in its tail frequently and often remaining on the bottom, although at times it can swim freely.

The Final Change.

Unfortunately it could not be induced to change further. The next change would almost certainly produce a true crab, and in all probability this would find a tiny Pinna and enter in. It is not known for certain how early a pea-crab enters its host, but small mussels are often found to contain very small crabs.

Except for Thompson's work referred to above, and a very brief note on the newly hatched Pinna pea-crab by Gourret from Marseilles, these facts relative to the pea-crab larvae are new. The chief interest lies in the different character of the two larvae showing adaptation to different habitats, and a much shorter life-history in the larger species.

FIG. 5.
THE LAST LARVAL STAGE.
(1) Megalopa or last larval stage of pinna pea-crab, from second zoea from Plymouth. (2) Adult female pinna pea-crab from Naples.

A Shakespeare Problem.

THE Master of Jesus College, Cambridge, whose interesting "Chapter in the Early Life of Shakespeare" recently attracted wide attention, has now set himself to solve another problem, "How Shakespeare 'Purged' Jonson" (Heffer. 2s.). The matter has its root in a play acted in 1601 by Cambridge students, and evidently written by one who had a particular acquaintance with the stage in the last years of Elizabeth. In the dialogue of the *Return from Parnassus, or the Scourge of Simony*, as this play was called, doubts are cast on the qualifications of student actors, one of them remarking that not only does Shakespeare confound their class, but Ben Jonson, too. However, he finds some consolation for this attack in the case of Jonson, for though, he says, "the pestilent fellow brought up Horace giving the Poets a pill . . . our fellow Shakespeare hath given him a purge that hath made him beray his credit."

The reference is undoubtedly to the war which raged from 1599 to 1601 between the player-poets and Jonson, caused by his method of satirizing the actors, as it is in one of the plays concerned that the character of Horace is introduced; but exactly what was Shakespeare's part in the quarrel has not hitherto been definitely determined. The solution adopted by Sir Sidney Lee, that the purge merely meant that Shakespeare had outstepped Jonson in popular esteem, takes no account of the graphic comparison with the emetic, while "beray" indicates to defile with filth. It seems, then, that Shakespeare's method was to caricature Jonson, in an illusion to some happening which was recent and notorious in 1601, as all the literary-dramatic world took part in the poets' war. From a study of the actors in the plays running at the time, it appears that Shakespeare withdrew from Jonson's *Every Man out of his Humour*, played at Christmas, 1599, but was again in the caste of *Sejanus*, a tragedy which Jonson presented later in 1603. The purge must therefore have been administered in a play performed between these dates, before a reconciliation had taken place; and the possible pieces reveal it in the person of Jacques, the melancholy figure in *As You Like It*.

This discovery of Shakespeare as a partisan in an ephemeral quarrel, condescending to personal satire, is one which was quite unexpected. The book must be left to disclose the full story, but the interesting conclusion is drawn that Jacques stands for something more, and that it was against a new type of dramatic "humour" that Shakespeare directed his attack.

How the Modern Archæologist Works.

By Lt.-Com. Victor Trumper, R.N.R.

The many accounts of excavations appearing in DISCOVERY *deal primarily with specific finds in ancient history, rather than with detailed methods. Much interest therefore attaches to the following account of modern archaeologists at work, which is based on a typical expedition in Palestine.*

THE life and work of a professional excavator are often vaguely understood by the general public. From time to time news of sensational finds is made known in the Press, and so the popular idea of an excavator is one who goes to a place and digs up golden statues, priceless vases, marble urns, or the richly decorated mummies of the Pharaohs of antiquity. As a matter of fact, however, the modern excavator is looking for history rather than for objects of intrinsic value. If he finds any gold bars, so much the better, for they help to pay for the season's work. If he finds a beautiful piece of statuary, so much the better, for it sooner or later gets into the Press, interest is stimulated, and subscriptions to the work come along. The most sensational discoveries are sometimes a profound disappointment to the true archaeologist, as they may contain nothing that materially advances our knowledge of history.

THE SITE OF THE EXCAVATIONS.
Tell Jemmeh occupies a commanding position on the edge of a dry water course. Its name, also, suggested that it had been the site of previous occupations.

The archaeologists of a past generation enriched our museums to a large extent, for they often had virgin sites to work upon, but according to modern views they destroyed ten times more than they found. If only the modern trained archaeologist could have the sites and chances that they had, the science of archaeology would have been much further advanced than it is at present.

Recently I had the privilege of a short stay with Sir Flinders Petrie's expedition in southern Palestine, and was able to observe at first hand how the archaeologist works under modern conditions. A famous cookery-book recipe for jugged hare, which began "first catch your hare," may be adapted for archaeology, "first find a site"; and that is where knowledge, training, deductions, experience, flair, and the sixth sense come in. Anyone can dig with the possibility of finding something, but it is the successful expert who digs in the right place, and there are the thousand and one things, intangible to the lay mind, which guide him in the choice of a site.

The actual place was chosen by Professor Petrie for various reasons. It was an obvious "tell," which is the name given to desert mounds bearing traces of previous occupation. Then there was abundance of pottery about, but none later than Greek, showing that the site had not been occupied in Roman times. It was also near to Umm Jerrar, and the analogy with other sites in Palestine would lead one to suppose that it might be the city of Abimelech, King of Gerar, with whom the patriarchs Abraham and Isaac had dealings (see *Gen.* xx. and xxi.). It was also in a very fine strategical position, such as would be chosen for the capital. After the site had been decided, the next question was the permit from the Palestine Government. This was obtained, and happily the hill-top contained no cultivated ground. There were no rapacious owners to compensate, such as hampered the recent Palestine Exploration Fund excavations on the Hill Ophel outside Jerusalem; funds which ought to have been used for digging and publishing expenses, had there to be used to placate owners of cabbage patches, who, as soon as they found the land was wanted, immediately put an outrageous price on it.

As soon as the preliminaries were finished, two assistants were sent to the site to build huts. These were simply made of mother earth, kneaded up with water, exactly as were the bricks which were later found during excavations. The roofs were sheets of

corrugated iron. A low walled enclosure was made in front, half of which served as a drying and airing ground for clothes, the other half being used for the storage and sorting of pottery.

A word may be said here on the subject of water. As there had been a failure of rains in the district, the nearest well was about two miles away. This, however, was distinctly brackish, and was not rendered less so by the fact that a woman near, who was fearing a visit from the excise officers, dumped two bags of smuggled salt down the well! The main part of the drinking water had to be fetched by camel from Gaza, about nine miles distant. Later on, after some heavy rain, an old Roman cistern half a mile away filled up, and water for certain purposes was obtainable from that. The well in the vicinity supplied the water for the native labourers, who averaged about 350 men, and the Gaza water was used by the English staff, which numbered eight, including three ladies. If by any chance this supply failed and the staff were reduced to the use of the local water, there was no temptation to overdrink themselves, and one understood why good fresh water is always called in the Near East "sweet water." The supply of water for the expedition cost not less than a pound a week.

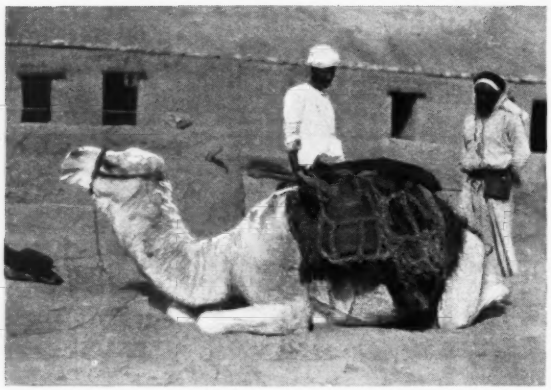
MUSTERING WORKMEN AT THE FOOT OF THE TELL.

[Men were plenteous owing to a local drought having suspended agriculture, but there was difficulty in obtaining boys to work as carriers for the excavators.

The next thing was to recruit local labour, and in this case the task was not to get the men, but to refuse them. In that particular district south of Gaza, as mentioned before, there had been a complete failure of the winter rains, and the ground was so dry that ploughing was useless. Hence agriculture—the only occupation now that raiding neighbours is made unprofitable by the efficient police supervision—was at a complete standstill. In January, the time of which I am writing, the crops would normally have been about six inches high, but owing to the drought, the seed was not sown and the ground not even ploughed. The nearest water was the well two miles away, and the Bedawin had to lead their cattle and sheep daily to this place to keep them alive. They would be able to pick up a few blades of vegetation on the way. This statement can be taken quite literally, as I often watched the sheep, and it was quite a find if one blade of grass was within ten yards of another. Naturally after two or three weeks of this, the stock began to die, and an official computation estimated that thirty per cent of the cattle and sheep had been lost.

In view of this, it can be understood what a blessing the expedition was to the district, for to have from three to four hundred men and children in well-paid and regular work, at a time of great scarcity and stress, just meant the difference between subsistence and acute distress. The great difficulty was to get enough boys, for the arrangement is that one man digs, while one, two, or three boys, according to the distance, carry the earth away in small baskets to the dump. In this case the refuse could be thrown down the side of the hill, so there was seldom more than a fifty yards carry; but often in excavations the earth has to be taken even further, to avoid covering a place that might subsequently be wanted for operations. Unless there are enough boys to keep a man's digging clear, much time may be wasted.

Those in charge had to keep a sharp eye to see that men who had not been taken on did not mix themselves up with a gang, and so work for a day, claiming a day's pay under the plea that they had really been engaged but their name had been omitted from the pay-book. If one of the assistants noticed a man working particularly hard when he passed by, that man was closely interrogated, which frequently resulted in his being sent off, generally amid the mocking laughter of the other more fortunate ones. It was not pleasant to have to refuse men, who were really anxious and willing to work, and were on the borderline of starvation, but the funds of the expedition did not permit of indiscriminate payments, and unless there had been very strict and efficient supervision, the result would have been chaos. Practically all the locally recruited men had never done archaeological digging before, and so half a dozen trained Egyptian workmen had been brought for the more delicate jobs. It may be mentioned that some of these men were



ARRIVAL OF THE WATER SUPPLY.
Water for the English staff of eight archaeologists had to be brought by camel from Gaza, a distance of nine miles, as local supplies were brackish.

the grandsons of those who had worked for Professor Petrie when he first came to Egypt about forty years ago.

The system of payment was that a man received a full day labourer's wage, and he was also paid full value for any small objects that he found. This has been proved the most satisfactory method of working, for the workman gets the cash and the excavator gets the object. In the diggings undertaken by the Egyptian government no compensation for finds is given to the workman; as a consequence any excavation attracts numbers of illicit dealers, who buy the objects from the workmen, and the government get few of the finds except those that are impossible to conceal. Under Professor Petrie the workman gets the value in any case, but if he sells it to the dealer, he is promptly discharged. Naturally he prefers to keep a well-paid and steady job, and also this system makes for care with fragile articles, for it is soon learnt that broken fragments are worth less than a whole pot or vase.

The Palestine men had not been used to this sort of treatment, and when they were first told that they would receive so much for small objects found, according to the value, there was a pleased smile not unmixed with incredulity; but when on pay night every man got his full pay, and those who had been lucky or careful enough to find objects of archaeological value got the extra money as well, their faces were a study.

As already mentioned, the hill known locally as Tell Jemmeh was in a very commanding position, on the edge of a "wady" or dry watercourse, with no other high land within several miles, so that the view from the top was extensive. As a fortress it could dominate the southern entrance to the Palestine maritime plain. Work was commenced at the top on the north-west side, as that appeared the most promising, and within a day or two discoveries proved the accuracy of this forecast; walls began to appear, and in a few weeks it was possible to discern complexes of rooms. However, the problems were many, and the fact that the site must have been in occupation for several hundred years, and that the successive inhabitants had either built on, or dug into, their predecessor's houses, did not lessen the general confusion. Among the first finds were some more or less circular pits. These appeared to be made in the thickness of a wall, and at first seemed to be specially constructed grain stores, with an opening in the bottom to withdraw the grain into the room. Further excavation revealed the fact that while they were undoubtedly grain pits, they had been sunk at random after the room had been filled up. The people who made them probably knew little, and cared less, that they were digging into massive walls of mud brick, six or seven feet thick. Ten large round, shallow, plastered pits were found.

The walls of mud brick furnished many problems. It must be remembered that the bricks were formed of sun-dried mud from the ground on which they were built, and the mortar used was the same mud. Then, after the walls of a chamber had been weathered away to a few feet of their original height and the debris washed into the room, it was filled up by blown sand and dust, consolidated by hundreds of rainy seasons. Finally, as it had also been built over by successive peoples whose architectural methods were the same, it was difficult to trace the original wall, and one might easily dig through brickwork without knowing it.

WALLS UNEARTHED ON THE TELL.
The author explains the procedure in excavating these walls, which were made of mud bricks and hence readily confused with the soil.

When a wall was discovered it was carefully followed by one of the trained Egyptian workmen, who knew by long experience what was brickwork and what was simply silt.

While the top was being excavated and fresh problems were presenting themselves, the sides of the hill were thoroughly explored, and eventually work was commenced on an outlying spur.

A doctor who had kindly volunteered his help was kept busy not only with the minor hurts incidental to the excavations, but with the Bedawin from the district, who used to come with many and varied ailments. Not the least part of his work, however, was the examination of the burials found on and around the mound. As soon as bones were discovered, one of the Egyptian workmen was put on to clear the earth as much as possible. Then the doctor would come with callipers and tape to take careful measurements, especially of the skull, before anything was moved. Sometimes, in spite of every care, the skull fell to pieces in the process. One remarkably fine skull, before being moved, was covered with a layer of melted paraffin wax, which solidified and made a support, enabling the skull to be lifted. Then the dirt from inside was carefully removed, and a thick layer of wax was poured in; the outer layer was peeled off and then measurements could be taken. These showed that the cubic contents of the skull were 1750, whereas the average European skull of to-day only gives 1550.

Needless to say, constant supervision was necessary, and the Professor's assistants were kept hard at it—directing the digging, seeing that each man had his proportion of boys, and watching carefully when any new feature presented itself, such as a change of colour

WAXING A SKULL.

This process is employed in order to facilitate removal of skulls which are often discovered in decayed condition.

MORE DISOVERIES ON THE TELL.

These semi-circular niches were part of a complex of structures that may have been guard-rooms and look-outs on the top of the tell.

of the earth or change of slope of the stratification. All the broken pottery dug out was carefully separated, at intervals being sent down in baskets to the enclosure in front of the huts, and put in piles according to the part of the excavations from which it came. The staff would go through these piles of broken pottery, carefully brushing each piece to see if there were any characteristic ornamentations that would date it, or any inscribed pieces usually known as ostraka—a tedious but very necessary job, if all the evidence is to be garnered. A dated piece of pottery and its exact place of provenance may give the clue, sought for several weeks, to the meaning of walls and their destruction.

One day a little skeleton was discovered in the digging, and while the bones were carefully lifted out, someone's sharp eye noticed a minute bead. Immediately one of the Egyptian workmen was called and a boy was sent post haste to the huts at the foot of the hill for a fine sieve; all the earth was put through it, and there was recovered a whole necklace. It was of small intrinsic value, but a pathetic reminder of some mother's love and care in a far off age.

Photographing, planning, and taking levels are most important parts of modern archaeological work, too often neglected in the past, and sometimes even now neglected. Only with true relative levels, careful photographs, and accurate plans, can correct deductions be made and opinions formed, for when a site is fully excavated the concrete evidence lies in the record. When sandstorms or heavy rains occur, which prevent outdoor work, the staff are busy piecing broken pottery together, making scale drawings of all the objects found, discussing their significance, and elaborating future plans.

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Industrial Uses of Ultra-Violet Light.

By L. V. Dodds.

Ultra-violet light is finding increasing application in the chemical and other industries. Its use in examining documents and paintings provides a new weapon to supplement the X-ray.

MANY exaggerated claims have been made for the artificial sunlight lamps now used so extensively, yet some remarkable results have been obtained both in the therapeutic and technical use of this new science. The medicinal value of ultra-violet light has been discussed in *Discovery** already ; and many industrial processes, especially those in which chemicals are employed, are also being assisted by the light, which both increases and accelerates ordinary chemical action.

Ultra-violet light is invisible. Both this and visible light are measured in Angström Units, one A.U. being the length of the largest X-ray or one ten-thousandth of a millimetre. Visible light ranges from 7,500 A.U. to 3,900 A.U., and that portion of the ultra-violet group which is most biologically active lies between 3,000 A.U. and 2,000 A.U., most of which is not obtainable from natural sunlight, due in England to the pollution of the atmosphere. A recent report of the Medical Research Council states that " the acetone-blue gauge shows that, on the average, two-thirds of the ultra-violet rays are cut off by smoke and dust pollution of the atmosphere in the city of London." Ordinary window glass cannot transmit rays shorter than 3,000 A.U., so that those of most value to health are eliminated entirely. " Vitaglass," however, a material invented by Mr. F. E. Lamplough to replace window glass in all its uses, will transmit as much as eighty per cent of the essential rays from the sun, and this is now being used extensively in hospitals, solaria, and private homes.

Production of Rays.

There are various methods of generating these rays artificially, and the one used most extensively, chiefly owing to its comparatively low cost and convenient method of working, is by means of the mercury arc quartz lamp. To describe the process briefly, a direct current of electricity is passed through the vapour of molten mercury contained in a vacuum quartz generator, and electrons in the form of ultra-violet energy are driven off similarly to X-rays. Quartz will transmit all the rays and also resist the heat. This principle governs all lamps of this type, though the fitments and attachments vary considerably according to the use to which the lamp is applied. The glaring light which appears when a sunlight lamp is operated is of no material value, and it is possible to eliminate this altogether by using specially constructed filters. Thus, when the lamp is switched on, nothing happens to all appearances, yet a powerful, unseen beam of ultra-violet energy is created which is being used now in many different ways.

Photography in Darkness.

The ability to take a photograph in total darkness is possibly not of great practical value, but it instances one of the curious ways in which ultra-violet light can be used. A photographic plate is very sensitive to the radiations, and in ordinary daylight photography it is often necessary to use colour filters over the camera lens to reduce or intensify the action of the rays from the sun. When the mercury arc quartz lamp is used, however, the energy created is four times more powerful than that produced by the sun in England, and, in consequence, the action on the plate is greatly increased, so much so, that visible light becomes of such secondary importance that it can be eliminated completely.

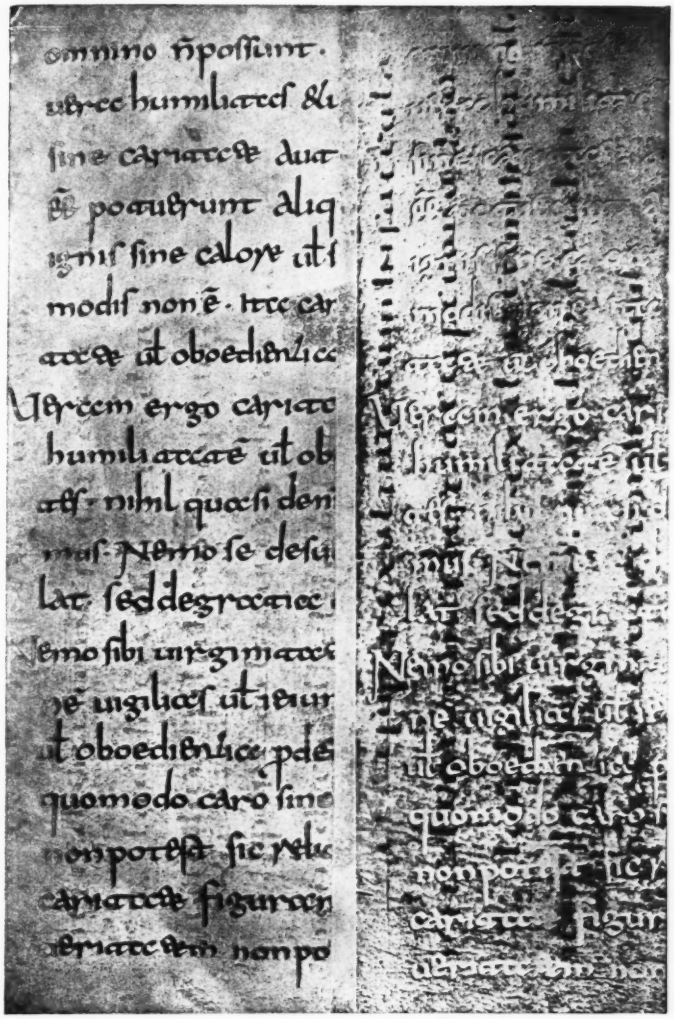
To make an exposure in total darkness, an ordinary camera fitted with a quartz lens is focussed on to the desired object and the line of the lamp beam is similarly directed. All illuminations are put out, and when the lamp is operated the visible light is filtered away and a simple instantaneous exposure made with the camera. After development a negative is obtained quite equal to one which is taken with magnesium or similar illuminant. Eyesight is very sensitive to the radiations, and if a figure is included in the picture the eyes should remain closed throughout the exposure to avoid injury. A single experience may not be harmful, but as some eyes are affected to a greater degree than others, it is advisable to take no risk. The operator wears the usual type of goggles made for the purpose.

An adaptation of this method is used in the making of micro-photographs in metallurgy. Difficulty is often experienced in focussing, which has to be done by means of a fluorescence screen and must be very exact. The advantage of using ultra-violet light in this way lies in the fact that some of the constituents

* " Recent Developments in Ultra-Violet Irradiation." By C. A. Cooper. February, 1928.

of steel, which look very much alike when photographed by ordinary light, absorb ultra-violet light selectively, and so appear sharply differentiated when the micrograph is made under this illumination.

Most important of modern experiments with invisible sunlight is the discovery of fluorescence. American scientists have stated that every known substance will show a fluorescence under ultra-violet light, and that the unknown can be determined by comparison with the known. Whether this is true for every substance has not yet been proved, but it is quite certain that a very large number of substances do show this fluorescence, which appears as a curiously glowing light varying in colour according to the material examined. A special screen is used for noting this phenomenon, consisting of an arrangement of coloured glass coated with a gelatine film containing a chemical substance in solution, to which a solution of another substance in water is sometimes added. Only radiations between 3,300 A.U. and 3,400 A.U. can pass through this screen, and these, of course, are invisible. The best known of such filters is the Wood filter, in which copper sulphate and a deep orange dye, nitroso-dimethyl-aniline, are used. Recent experiments have produced a screen of deep black, which it is claimed will supercede other filters by its more convenient method of manufacture and working. When the rays strike a substance capable of fluorescing, the short wave-lengths are changed into visible light of longer wave-length, and the curious glow is seen which is known as fluorescence. By noting the colour variations it is possible to identify like substances with absolute accuracy in many instances, and this method has already had numerous practical results which are extremely interesting.



[*Photograph by courtesy of Prof. G. R. Kogel.*

PALIMPSEST PHOTOGRAPHY.

On the left is a manuscript photographed in daylight, and on the right the same under filtered ultra-violet light, showing the older writing underneath.

Germany has adopted the new method enthusiastically, and all the large banks and police stations have apparatus installed for use in criminal investigation. In 1926 the German banks found that a large number of foreign railway bonds had been so falsified as to antedate their maturity and so increase their apparent value. The alterations were done perfectly, but they were obvious at once under ultra-violet light by the various inks used fluorescing differently. None of the bonds in question were accepted until they had been submitted to the test, and a very large sum of money was saved. In cases of arsenical poisoning the presence of the drug can be found, no matter by what foreign substances it may be surrounded, and in a recent important trial in Berlin a fluorescence test for arsenic was admitted as evidence for the prosecution.

The Bank of England has apparatus for testing counterfeit bank notes, while both Scotland Yard and many large jewellery establishments examine suspected gems beneath the light. Diamonds glow like beautiful

blue lamps, but imitations are absolutely lifeless and dull. Criminology has a very potent weapon available in invisible sunlight, and a well-known authority has declared that for this purpose ultra-violet lamps are more serviceable than a microscope.

In olden times when parchment was used to write on, it was not thrown away when time had made the document worthless because of the expense of producing the material. Instead, it was carefully cleaned by chemical or mechanical means, and used a second and even a third time. In many cases the more ancient writings would be of much greater historical value if it were possible to read them, and, now, by the use of the Hanovia analytic quartz lamp, they can be deciphered. Even after the removal of the original writing traces of tints and dyes were left in the parchment, and under ultra-violet light these show different fluorescences from the parchment itself, and also from the later tints, which can be removed or neutralized by the use of certain photographic colour filters. When a photograph of the parchment is taken under the rays, the superimposed writings appear as if in outline type, that is, having a white ground and a thin, black edge to the lettering. Underneath this can be seen clearly the original script, which is dark grey in colour. Certain imperfections must be expected due to the varying action of the cleaning process, but it is seldom that there are any difficulties in deciphering due to visibility. By this means important material for the study of history has been produced which was unavailable hitherto.

Textiles and Silk.

Textile manufacturers use ultra-violet light for separating fabrics much alike but actually different, while mildew and bacteriological damage can be detected. The health of silk worms may not appear to be an important matter, but upon it is dependant the quality of the silk produced. Many breeders periodically test the worms by fluorescence and pick out any unhealthy ones, thus keeping the strain good. The secreting organ of a healthy silk worm fluoresces white, while the blood shows a yellow fluorescence, any variations in colour denoting an unhealthy insect. The possibilities of this test being applicable to the human body also may be among future developments.

For some time past hospitals have exposed all the milk used to ultra-violet light, which produces complete sterilization and is also said to increase the calcium content of the milk. Many researches are being made regarding the irradiation of foodstuffs, and some have already been placed on the market on a commercial scale. Butter is sterilized by being spread out on an endless band which passes before a sunlight lamp. There is a slight change in chemical composition, but very little difference in colour or taste. Butter oils, cod liver oil, and others containing anti-rachtic vitamins emit a yellow fluorescence, while inactive oils, such as olive oil and pea-nut oil, show white. When the latter are exposed to strong ultra-violet light they gradually show a yellow fluorescence which deepens in colour according to the intensity of the rays. This is said to prove definitely the food value of such irradiations.

A Sensitive Test.

Fluorescence tests for the presence of some particular materials are possible to an extraordinary degree of accuracy. Naturally some substances fluoresce more than others, and quinine is specially sensitive, being found even in water solutions of 1 part in 100,000,000. Uranin is more sensitive still at 1 in 1,000,000,000, and in the case of aesculin even 1 part in 10,000 millions can, under favourable circumstances, be detected by its distinct fluorescence. A method of investigation is now available which in its precision approaches the spectroscope.

Various methods have been evolved for measuring the intensity of ultra-violet light, which has formed one of the principal difficulties to successful use in commercial enterprises. Professor Leonard Hill, F.R.S., invented the infusoria killing test and the power was measured in I.K. units. He was responsible also for the methylene-blue test which is bleached under the action of ultra-violet light. This method is used in the British meteorological records. The convenient uviometer seems to be a solution of this difficulty, and its invention by McKenzie and King has done much to increase the accuracy of ultra-violet light treatment, especially in therapeutic and bacteriological uses. This apparatus is based on the freeing of chlorine from carbon tretrachloride, and a colour comparison is made between a set of standard tinted specimens of carbon tetrachloride which are built into the machine.

The ways in which artificially generated ultra-violet light can be applied are extraordinarily varied. In the arts, in chemical analysis, in medicine and in technical processes in industry new methods for using apparatus are constantly being discovered, and in consequence the rays become of ever-increasing importance. Much of the work in this new branch of research is still experimental, but sufficiently successful results have already been obtained to prove that the application of artificial ultra-violet light is one of the outstanding achievements of science.

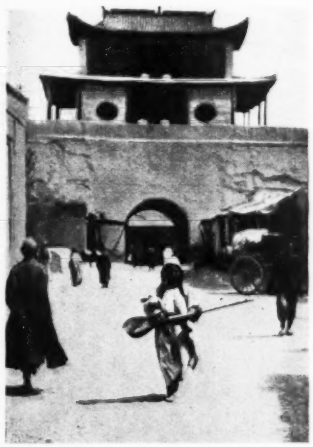
Ordam Padshah, A Second Mecca.

By Lt.-Col. P. T. Etherton,

Late H.M. Consul-General in Chinese Turkistan.

Although Ordam Padshah is visited by pilgrims from all over Asia, so far as is known only five white men have ever journeyed to this sacred shrine. The author enjoyed this experience while in Turkistan.

HIDDEN away in the heart of Asia, amidst a wilderness of shifting sandhills, some of them two hundred feet in height, lies the shrine of Ordam Padshah, second only to Mecca in Moslem eyes. Pilgrims flock to it from all parts of Asia, but during just on a thousand years only five white men have penetrated to this sacred spot. Apart from the antipathy shown to Europeans visiting Moslem shrines of so exceptional a nature, the physical difficulties to be overcome are formidable in the constantly moving sea of sand which has in the past engulfed forests and filled up large rivers.



THE GATE OF YANGI HISSAR.

Ordam Padshah is about ninety miles north-east of Yarkand in Chinese Turkistan, and it marks the spot where the historic battle took place ten centuries ago for supremacy between the rival religions of Mohammed and the Buddha, in which the Buddhists were defeated, thenceforth the Moslems becoming the predominant religious element in Central Asia. There is a total of 730,000,000 Moslems and Buddhists in the world, so the magnitude of the struggle, and the issues at stake, can be well imagined.

Yarkand is a city of the Arabian Nights, and the glamour of romance hangs over it from its association with the greatest story-book of all times. Seventy miles north of this city of Sinbad the Sailor and Aladdin's Lamp is Yangi Hissar, whence I set out to reach Ordam Padshah. For the expedition I was accompanied by the Chief Beg, or official in charge of the district, and a mixed following of soldiers and servants, the Moslem leaders—contrary to predictions—raising no objection to my journey. Since the war the British attitude towards Moslems generally, and our protection of the Holy Places, had created a profound impression, this being probably the reason why the project was not opposed and fanaticism for the time being was put on one side.

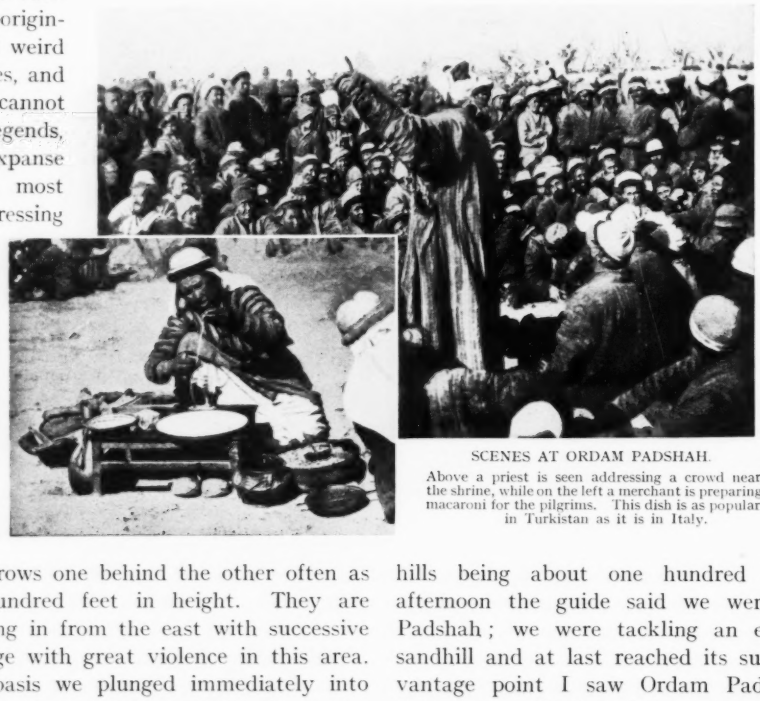
On arrival in Yangi Hissar I dined with the Chinese governor. The meal was a regular banquet; we were served with Chinese delicacies such as shark's fins, bamboo roots, seaweed, fermented eggs, stag's tendons, sea slugs with at least a hundred legs, lotus seeds, pork crackling, eggs preserved in chalk—the older the egg the greater its edible value—duck's brains and grilled rats. A grilled rat restores the hair when you are bald, whilst a stewed black cat will ward off a fever. The *pièce de résistance*, however, was a number of newly-born white mice served alive, to be dipped in treacle and swallowed whole like a prairie oyster. I have eaten the food of over thirty different countries, but I could not face the mice, and the host was much upset, remarking that I didn't know a good thing when I saw it!

EAGLES USED BY PRIESTS FOR HUNTING.

Ordam Padshah is one of the few places where these birds are still used for hunting, the pastime being a popular one with the priests.

This dinner afforded a quaint study in human nature as seen in little-known regions of the earth. A Chinese general of high rank was also dining, and on taking his place at table gave his richly-jewelled and bedecked head-dress to an attendant behind his chair. The latter had his hands occupied with a rifle and sword, so cast around for a peg on which to hang his master's magnificent hat, but not perceiving anything suitable he promptly put it on his own head, and there it remained until the general left.

On leaving Yangi Hissar the track passes through an oasis and then becomes lost in the immense desert of shifting sand that stretches for two thousand miles across Asia to the east. This desert has originated all sorts of weird and ghostly stories, and certainly one cannot marvel at the legends, for the endless expanse of sand has a most dismal and depressing effect. There is no sign of human, animal, or vegetable life, not a sound of beast or bird, nothing to relieve the sepulchral silence. The formation of the sandhills is always the same, successive rows one behind the other often as much as two hundred feet in height. They are continually pouring in from the east with successive storms, which rage with great violence in this area. On leaving the oasis we plunged immediately into this sea of sand, the going being exhausting: for every step sinks in to the knees and often up to the waist. All day long we struggled over these sandhills until nightfall of the first day found us in a small clearing in the wilderness, a tiny island, so to speak, of reed and mud-built huts. This was the advanced outpost and first contact with the mysterious shrine of Ordam Padshah, for here lives one of the priests and his assistants who supervise the pilgrim traffic. I had a long talk with them in their own language, and they showed me some magnificent eagles that are used to bring down wild boar and gazelle, this being one of the few places in the world where eagles are still used for hunting purposes.



SCENES AT ORDAM PADSHAH.

Above a priest is seen addressing a crowd near the shrine, while on the left a merchant is preparing macaroni for the pilgrims. This dish is as popular in Turkistan as it is in Italy.

The fast of the Ramazan, the greatest religious observance of the Mohammedan faith, had recently ended, and I learnt many curious details about it. The fast is for thirty days, and no food whatever must be taken between dawn and nightfall. It is null and void if perfumes are smelt, and there must be no form of material pleasure during the prescribed hours. The true believer must not swallow his saliva, and the very orthodox ones will not open the mouth to speak for fear of breathing more air than is essential. During the hours of complete darkness eating is permitted, but no particle of food must be left in the mouth, for even a grain of rice between the teeth is sufficient to destroy the fast and the reward in the hereafter is decreased. A Mohammedan must not touch a woman, and to kiss her is disastrous.

The next morning I set out on the final stage that took me to the shrine. Once more we struggled over countless sand dunes, the average height of these moving hills being about one hundred feet. Late that afternoon the guide said we were nearing Ordam Padshah; we were tackling an exceptionally lofty sandhill and at last reached its summit. From this vantage point I saw Ordam Padshah (My King's Palace), a collection of some twenty houses and a mosque, near to which was the most curious religious monument in the world, for it marks the spot where the leader of the Mohammedan army fell with many of his best warriors. It is a sheaf of sticks and poles sixty feet in height and over one hundred feet in circumference at the base. The sticks have been deposited by successive generations of pilgrims, and the wealthy amongst them deposit poles and beams of large size brought with infinite labour from all over Asia. My followers were awed and deeply impressed at the sight of this sacred spot. We moved slowly down the sandhill to the outskirts of the settlement, where I was met by the chief priest and his following.

They were quite friendly, and the sheikh himself, with a long white beard and venerable appearance, made a most impressive figure. He led me through huge walls of sand to the guest chamber, a small two-roomed house raised about six feet above ground level with a platform of beaten earth.

Night was already closing in, and after a "dasturkhan," or feast, laid out on the floor, of dried fruit, nuts, roast mutton, meat dumplings, and a variety of cakes, the high priest left me, saying as he went out, "Venture not from your chamber until the dawn, for the spirits of the lost pass up and down in the still hours of the night and it is death to hear them." So I stood fast and the next morning in broad daylight went out on a tour of the place. The permanent staff consists of the chief priest and about seventeen subordinates, and the houses in which they live are hemmed in on every side by a wilderness of shifting sand. The principal religious building is that used for the reception of offerings brought by the faithful. I saw here and in an annexe the most wonderful collection of carpets, brocades, gold and silver ornaments, precious stones, jade, and other articles which we usually associate with the Arabian Nights. There were five bowls set apart for the votive offerings, the largest of bronze, six feet deep and five feet in diameter at the top, said to have been cast in the days of the Mohammedan champion himself—a thousand years ago. Apart from its size and intrinsic value, its contents in the height of the pilgrim season can be imagined, and I thought what a "lucky dip" it would make. Another bowl was of copper, of about the same size and capacity, and was brought here with infinite difficulty by a famous Amir of Central Asia who made no fewer than three pilgrimages to this sacred spot. He was the most noted character in Asiatic history, and when at the zenith of his power maintained a large personal household, including a harem of three hundred women.

THE SACRED SHEAF.
This remarkable religious monument, over fifty feet high, is composed of poles brought by pilgrims from all over Asia.

THE MOSQUE AT ORDAM PADSHAH.

THE MOSLEM HIGH PRIEST.
This official conducts the religious rites at the mosque. Behind him are further offerings.

On one day during the pilgrim season the huge bowls are used for cooking purposes, and "pilau," a form of mutton, rice, vegetables, and spices, is prepared for the vast host of devotees. The bronze bowl is in greatest favour from its age and sacred association with the Mohammedan leader, and great is the competition to secure a morsel of the contents for not only does it cleanse from unrighteousness, but carries with it a passport to Paradise.

The crowd was a highly cosmopolitan one, and more than twenty different tribes and races of Mohammedan Asia were represented. There were many Wakhis, whose spiritual head is that well-known figure the Aga Khan. It is curious to think that this wild and remote people, whose lives are passed amongst the biggest peaks and glaciers in the world, should have as their head the genial sportsman so familiar to English racing and social circles.

Much more I saw in Ordam Padshah, and on leaving I commented on the fact that the place has escaped being swallowed up by the sand. It really is remarkable, but the chief priest replied dramatically, "The sand will not touch the resting-place of the holy martyr; it passes on in its course, giving peace to the sacred spot and it will do so to all eternity."

The Great Californian Dam Disaster.

By R. C. S. Walters, B.Sc., A.M.Inst.C.E.

That the difficulties in the construction of a dam are not generally realized, even by engineers, is borne out by the collapse of a newly-built dam in California. The facts suggest that further research is required.

THE report of the commission of engineers appointed by the Governor of California, U.S.A., to inquire into the great St. Francis dam disaster has now been published. The dam was built in 1924-5 across the San Francisquito Canyon, some forty-five miles north of Los Angeles, and formed a storage reservoir for the water supply of the city. This reservoir was filled to about three-quarters the height of the dam from March 1926 to March 1927, and from then until the disaster this year the water-level was at or near the top of the dam (Fig. 1).

The structure collapsed suddenly at midnight on 12th March. The dam retained a depth of water of nearly 200 feet and a volume of 38,000 acre-feet, which was suddenly released into the valley below. The San Francisquito Canyon, as it is called, is comparatively narrow for a distance of some ten miles, and then joins the Santa Clara River, situated in a wide valley in the Ventura country. From this point the river flows westwards for some fifty miles to the sea, and along its course there are several small cities and a railway. Los Angeles itself, however, is some forty miles from this valley.

When the burst took place the flood swept through the canyon with a depth of 75 to 125 feet. The sides of the canyon were swept clean (Fig. 2), and blocks of the dam were carried for miles down the valley; thus a block weighing perhaps two or three thousand tons was taken for nearly half a mile below the dam. When the flood emerged from the relatively narrow canyon into the Santa Clara valley, which is over a mile wide, the depth of water and the rate at which it travelled was much lessened; but a vast amount of damage (estimated at £4,000,000) was done by reason of towns being inundated, bridges swept away, railways and roads torn up, and water-works and sewage works being destroyed. In one instance a bridge, formerly spanning a channel 150 feet wide, was completely obliterated, and the channel itself enlarged to a width of 500 feet. In another case, a railway track with sleepers was transported a hundred yards and turned upside down. The water took some three hours to

FIG. 1.

VIEW OF THE ST. FRANCIS DAM BEFORE THE DISASTER.

This concrete dam was 700 ft. in length, constructed in a concave curve having a radius of 500 ft. The first break took place in the portion seen on the left (*i.e.*, right bank side). This and the other photographs are reproduced by courtesy of *Engineering*, London.

travel forty-five miles. The loss of life was over four hundred, nearly half of which appears to be accounted for by those who were in the construction camp a few miles below the dam.

According to details in the American *Engineering News Record*, the dam was constructed of mass-concrete and was curved on plan, having a radius of 500 feet. The maximum height was 206 feet above the ground level of the bottom of the valley, and the width 176 feet. The total length was 700 feet. After the failure, a central portion measuring 75 feet (of the 700 feet) is still standing, but on the north-west side (left hand of Fig. 3), there is a great gap where 250 feet of the dam was completely removed. On the south-east side there is another great gap of about the same size. No trace whatever remains near the dam of any concrete that filled the left-hand gap, but most of the concrete from the right-hand gap remains in a broken condition at the foot of the dam; from this it is inferred that the left-hand side gave way first, a fact which the commissioners definitely attribute to defective foundations.

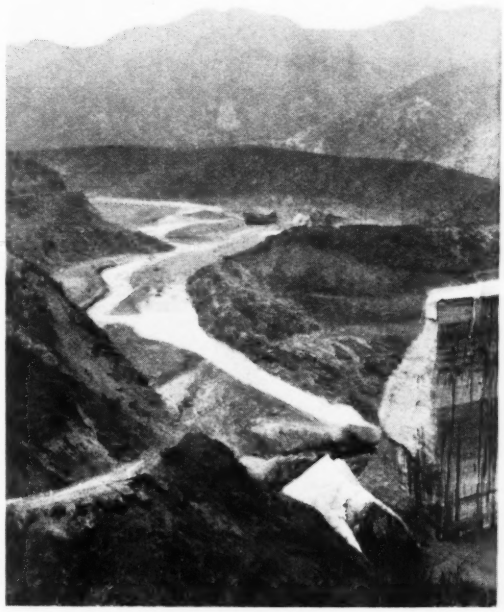


FIG. 2.
THE CANYON AFTER THE BREAK.
Looking down stream, the high-water mark of the outflowing water is clearly seen along the hills on both sides of the valley.

The dam is built upon a line of a geological fault between conglomerate, a rock composed of pebbles cemented together, and schist, a laminated rock of a slaty nature. The conglomerate is composed of small pebbles, which are embedded in a sandy micaceous detritus, and when dry it appears to be hard, though by no means good for a foundation. This is shown by laboratory crushing tests (500 lb. per sq. inch) and by the fact that when a piece of the rock is placed in water "a startling change takes place. Absorption proceeds rapidly, air-bubbles are given off, flakes and particles begin to fall from the sides of the immersed piece, and the water becomes turbid with suspended clay. In usually from fifteen minutes to an hour a piece the size of an orange has disintegrated into a deposit of loose sand and small fragments covered by muddy water. . . . Clearly, when thoroughly wet, the conglomerate at the north-western abutment (right bank) of the dam ceased to have the characteristics commonly denoted by the term rock."

It seems that water would penetrate easily through this rock under the concrete of the dam, especially in the vicinity of the fault. As the concrete was only taken down some eight or ten feet at this point, the hillside would rapidly disintegrate (as illustrated above in the small scale experiment), and would leave the great mass of the concrete of the dam unsupported. This concrete would break off along the planes of contraction.

The dam at the south-east end (left bank) is built upon schist. The strike is parallel to the course of the canyon and the dip is north-westerly. The laminations of the schist on the left bank may be likened to slates on the highly inclined roof of a house, hence the schist is naturally liable to slip, especially when the pressure from the dam is parallel to the planes of lamination. When the left bank collapsed an immense volume of water would scour into the schist and cause it to slide. This left the underside of the dam without support and caused it to shear out, bottom first, and fall on its upstream face (see Fig. 3).

The mere fact of the central and highest part of the dam having stood practically without movement shows that its design, construction, and foundations are right. Excavation for the latter was carried thirty feet below ground for this central and highest part, but, as stated above, the excavation for the sides was not so deep. Nevertheless, owing to the great wrenches of the two ends being sheared from it, the top has moved some eight and a half inches, presumably downstream. There is an automatic recorder on top of the standing portion of the dam, which would show the rate the dam emptied, but at present figures are not to hand.

The summing up of the commission is contained in three clauses: "(1) Failure of the St. Francis dam

FIG. 3.
REMAINS OF THE DAM.
The remaining middle portion and fragments of the east wing, view up-stream.

was due to defective foundations. (2) There is nothing in the failure to indicate that the accepted theory of gravity dam section is in error, or that there is any question about the safety of concrete dams designed in accordance with that theory, when built upon even ordinarily sound bed-rock. On the contrary, the action of the middle section, which remains standing even under such adverse conditions, is most convincing evidence of the stability of such structures when built upon firm or desirable bed-rock. (3) The failure of this dam indicates the desirability of having all such structures erected and maintained under the control and supervision of state authorities. . . . The disaster emphasizes the fact that, while the benefits accrue to the builders of such projects, the failures bring disaster to others who have no control over the design, construction, and maintenance of the works. The police power of the state certainly ought to be extended to cover all structures impounding any considerable quantity of water."

The geological and engineering difficulties in dam construction are not generally realized, even by engineers. The construction of a successful dam is the most difficult piece of engineering there is. Perhaps more disasters have occurred by the collapse of dams than by any other engineering structures. Not only should dams be constructed under the best geological guidance, but also they should be watched for signs after they are built. An engineer who has never had experience of a dam will gaily undertake its construction, imagining that it is the easiest thing in the world to throw an earth or concrete bank across a valley. To illustrate the difficulties involved, the case may be taken of an earthen dam with a core of puddled clay. In practice the parapet wall has sunk, this fact showing that the materials forming the bank have consolidated by the great pressure upon them, and the top of the bank is nearer the water-level than it was when the dam was built some forty years ago. Hence there may be a risk during a great storm—such as may occur once a century—of the water overflowing the top of the dam; in which case, of course, the soft earth and clay forming the bank would be quickly washed away, from the top downwards, until the whole dam would be demolished and the reservoir emptied.

An example of such a disaster took place at Johnstown, Pennsylvania, in 1889, when more than two thousand people lost their lives. This dam, built in 1840, was 930 feet long and 75 feet high; there was no central puddled clay in the dam, but the materials were made up of "impervious soil, rock, gravel, and sand-fill." The dam had remained sound for fifty years, but had not been watched; and the failure was due to a large flood overtopping the crest, contributed to by "a lowering and dishing of the crest, together with obstruction of the spillway." Other such failures include the case of the Dolgarrog dam in North Wales, in November, 1926. This dam was 3,300 feet long and 20 feet high, with footings 18 inches only in the clay. The foundation was scoured out, and the volume of water was so great that it overtopped and washed away an earthen bank lower down stream. Sixteen persons were drowned.

Lake Gleno dam, in Italy, failed in December, 1923, when six hundred people lost their lives. The dam was 143 feet high and 863 feet long, and poor foundation and construction work were the causes.

Summary of Causes.

To sum up, the following instances of dam failures have been cited by Dr. Herbert Lapworth*: (1) Failure by undermining, due to water-bearing beds below the foundation; there are about a hundred examples of this class in America alone. (2) Failure due to excessive leakage through open joints in the foundations. (3) Failure due to slipping or settlement of earthen embankments on a slippery or soft base. This class includes the Bradfield disaster of 1864, and numerous other instances in India and America.

In addition, failures have occurred owing to (4) insufficient spillway capacity and consequent overtopping. (5) Unequal settlement in the foundation, and (6) superstructure of the dam. (7) The ill-designed connexions of puddle to rock or concrete cut-off walls, and (8) defects in puddle. (9) Dam as a whole slipping on its base. (10) Dam overturning.

*_Transactions_ of the Institution of Water Engineers, Vol. XVI.

Economics and Education in America.

By J. A. Benn.

A new view of American economic conditions is suggested in the following notes, which are designed to describe the situation as it exists, rather than to comment upon its political aspects.

More particularly since the war, the United States has been extensively studied by British economists and journalists, as well as by business and trade union delegations. All these visitors have returned impressed by the general wealth and high standard of living, and they have mainly attributed it to machinery and mass production. A more intimate acquaintance with everyday American life does not weaken their conclusion, but it suggests that another and somewhat deeper explanation is to be discovered in the educational system.

Wide Opportunity.

As applied to the United States, Professor Marshall's definition of economics as not only a study of wealth, but on the more important side a part of the study of man himself, must certainly embrace the wide educational opportunities which every citizen enjoys. This influence is unusually marked in a country with few hide-bound conventions, where the population is constantly being recruited by immigration. During the past hundred years more than twenty-five per cent of the increase is attributable to this factor, and the figure had risen to thirty per cent when the restrictive laws of 1917, 1921, and 1924 were introduced. These new citizens enter the country as a break with the past, and begin another chapter in a consciously receptive frame of mind. President Coolidge once expressed such motives in connexion with education, when he said that his country did not wish its system to be based on Greek or Roman traditions but to be "supremely American." As a technical definition this remark is quite nebulous, but it exactly expresses the freedom with which the problem has been approached. An analogy given by Mr. St. Loe Strachey relates how when Roosevelt was convinced of the need for the Panama Canal, he refused to delay by reconsidering the engineering difficulties, but determined to "make the dirt fly" in the shortest possible time. In the same way, the Americans have not greatly troubled about the best type of education in the abstract but have made the dirt of learning fly. "The essential thing is to get the structure up. Later there will be plenty of time to consider how to decorate and furnish it. That, unconsciously if not designedly, has been the attitude."

In a country where State participation in the affairs of the people is comparatively undeveloped—except, paradoxically, in a few absolute measures such as Prohibition—it is unexpected to discover that the taxes provide £300,000,000 annually for elementary and secondary education. Public relief does not officially exist for the poor or unemployed, and insurance and pensions are practically unknown, yet nowhere in the world is free education more liberally provided or more generally regarded as a natural right. The charge of unequal opportunity can seldom be justly made, a fact which by itself confirms the American's belief in personal initiative and subconsciously inspires his attitude to work and to industry.

The British Budget provides £71,000,000 for the education of about 7,000,000 children, compared with the American scale of £300,000,000 for 24,000,000 children. Proportionately, the United States therefore spends twenty per cent more on each child. As these figures concern only those who are educated at the State schools, it will be inferred that larger numbers of American children attend these institutions—a factor which is probably the most fundamental in the social and economic life of the people. If in England it is the exception for those with more than a certain means to send their children to the State-provided schools, in America this condition is largely reversed. A "middle-class" parent seldom sends a boy to boarding school at least until he is fourteen, and after that age it is unusual to do so; he is sent as a matter of course to the local "public" school. Of the 26,000,000 school children in the United States, only 2,000,000 are registered in private schools; the figure for England is much less certain, but it appears to be 1,000,000 out of 8,000,000 children—more than one and a half times the American proportion.

The State Universities.

Another important factor is that the State-schools may be attended up to the age of eighteen, and large numbers can therefore attain university standards. Every American State maintains at least one university, and on an average three, at the public expense, in addition to the private institutions, which number altogether 500. There are more than 500,000

university students, besides some 200,000 attending technical training schools. The English and Scottish universities contain fewer than 50,000. Making allowance for the fact that the American population is two and a half times as large, there are four university students for every one in Britain. The agricultural state of Iowa alone has fifteen universities —as many as there are in England—although its population is but two millions.

Technical Training.

The standards vary considerably, and some are scarcely universities at all according to English requirements. In humorous vein, Sir Arthur Shipley once related an experience in a Western State, where he got into conversation in a railway carriage with a "college president"; but inquiry revealed that the Faculty at present consisted only of this dignitary and his wife, though it was "hoped to add to that number quite shortly"! Sir Arthur also remarked on the curious courses sometimes offered to students, citing the case of a young lady who intended to supplement Greek history and Shakespeare with lessons in pottery and jewellery. The subjects offered, that is to say, include many not taught in English universities. The provision of specific technical training is not so general as is often supposed, but some of the courses would only be found in England at the purely technical school. A writer in an American university journal has affirmed this tendency, in suggesting that "since industry is becoming more technical daily, almost every business is demanding a college training."

I may perhaps remark in parenthesis—lest I give the false impression that the American universities are not mainly concerned with cultural studies—that the new novel of a young graduate of Yale has been described as perhaps the most outstanding achievement in recent literature.*

That mechanical knowledge is second-nature to the American is indicated by the marked development of motor-cars and wireless, and he takes readily to machinery of all kinds. To what extent this faculty is based in education is not easy to determine; it undoubtedly also results from the struggle with prairie and forest, which still persists in some degree and has required all the mechanical aid that could be discovered. The effect of this attitude is at any rate marked in industry, and no American workman regards the tool as his enemy. In amusing contrast was the humiliating experience of an English psychologist, who asked a building labourer why he was pulling his barrow. The other men on the job wheeled theirs in front of them—surely this exception showed some subtle appreciation of mechanical principles. "Why am I *pullin'* it, Sir? Because I'm sick of the sight of the —— thing!"

Barrows in America have long been replaced, and the man who controls the automatic truck is probably himself on the verge of discovering a yet more efficient substitute. He is, of course, in danger of never pausing to ask himself whither he is heading. But whatever the future may hold, his mechanical outlook is certainly providing meanwhile an unsurpassed standard of livelihood, besides maintaining a level of education which is likely itself to yield a satisfactory answer.

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Arctic Expeditions.

A NEW departure in travel is offered this summer by Mr. Bee-Mason, of Burgess Hill, Sussex, who is organizing two Arctic expeditions for the general public. Owing to modern knowledge of diet and conditions the Arctic no longer has the terrors it once presented, and should afford a new holiday field for sportsmen and naturalists, as well as photographers. Mr. Bee-Mason was official kinematographer on the "Quest" with the late Sir Ernest Shackleton, and by an interesting circumstance he has secured the ship for the new expeditions. After a voyage of 2,000 miles to Spitsbergen, to the famous Guillemot Range in the Hinlopen Strait, the journey will be continued round Cape Mohn, and along the great ice wall which extends for over eighty miles. Walrus, seal and polar bear abound, and good sport is expected, including eider-duck and geese. The hundreds of reindeer at Spitsbergen are under the protection of the Norwegian Government, but application has been made for permission to shoot a limited number. Should ice conditions be favourable, the expeditions will make for Franz Joseph Land and will land there for a short time. The return journey will be made round South Cape and thence to Bergen. Each expedition will last six weeks, leaving Newcastle on the 30th June and 9th August respectively.

* Thornton Wilder's *The Bridge of San Luis Rey.* In Mr. Arnold Bennett's opinion "the writing has not been surpassed in the present epoch."

Unsolved Problems of the Moon.

By J. A. Lloyd, F.R.A.S.

It is still not known why the areas which make up the full moon's "face" are so much darker than the rest of the surface. The "man in the moon" is entirely discredited, but possibly some low form of life may exist.

It is scarcely a matter for wonder that the moon has been peered at through telescopes more often, and to greater advantage, than any other heavenly body. Of all such objects, with the sole exception of meteorites, it is the nearest to the earth, its distance being some 240,000 miles, or about nine times the circumference of the earth. In consequence, more is known about the visible surface of the moon than about many parts of the earth. It has been surveyed and charted with a painstaking precision that almost beggars belief. Of late years, especially since the completion of the giant reflecting telescopes at Mount Wilson, U.S.A., all the resources of photography have been called upon to aid the lunar cartographer in his tedious work. And yet, in spite of all this activity, the moon's surface presents a formidable array of unsolved problems which seem destined to exercise the brains of astronomers for some considerable time to come, if, indeed, they are ever finally settled.

The Origin of Craters.

A very casual glance at the moon through a pair of field-glasses or a small telescope reveals a vast number of circular formations, in some places so massed together as actually to overlap. These are the most characteristic features of the moon, and are popularly termed "craters." They can be counted by thousands, and range in size from vast ramparted plains, more than a hundred miles in diameter, down to tiny pits, so small as to be hardly discernible, even in the most powerful telescopes under ideal conditions. Most of them are distinguished by a central cone or a group of conical peaks. The ring-formations are generally divided into classes or types, mainly according to their size, such as walled plains, mountain-rings, ring-plains, craters, craterlets, crater pits, and crater cones. The nature and origin of these curious structures constitutes the first and most important problem in selenology.

There have been many theories advanced to account for the so-called craters. Some are quite plausible, while others are merely ridiculous. One theory developed during the last century was that the circular crater walls were built up by showers of ejected matter shooting up from a central vent, like a fountain. It is, however, difficult to imagine craters of one hundred miles and over in diameter being formed in this way, even granting that the force of gravity on the moon is only one-sixth of what it is on earth. Some of the smaller craterlets might conceivably have been produced in this way, but certainly not the larger ones.

Another view which has had not a few advocates, holds that the lunar craters are the result of direct impacts by gigantic meteorites falling on to the moon from space. The effect has been produced experimentally by shooting clay balls into soft clay, whereby striking reproductions of the craters of the moon have been obtained, even to the central cone which is such a common feature of the lunar formations. This view has not, however, been favourably received, and the arguments against it are overwhelming. For instance, how is it that the earth is not marked in the same way, since it is just as exposed to the meteoric hail as the moon, as well as being a more massive body? It is true that there is a crater in Arizona which is believed to have been formed by the fall of a huge meteorite, but this unique example is only three-quarters of a mile in diameter, and on the moon would rank as a very insignificant object. It has been urged as an argument against the meteor-fall theory that, in order to produce the crater effect a meteor must strike the moon's surface vertically, and it is well known that meteors strike the earth at all angles. But, in fairness to the theory, it must be stated that the Arizona crater appears to have been formed by a meteor falling at a considerable angle, since most of the meteoric matter is gathered to one side of the crater, and yet the pit is fairly circular.

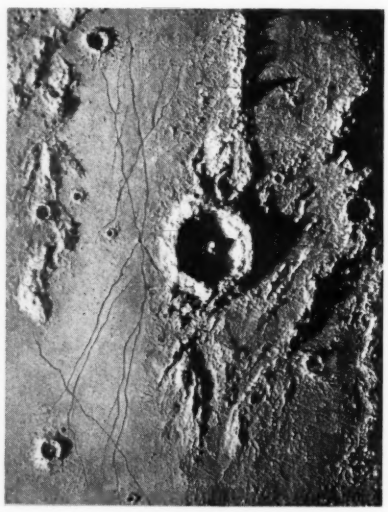
Volcanic in Character.

Yet again the lunar crater rings have been regarded as the wrecks of burst lava-bubbles; as being due to local whirlpool movements in the semi-molten materials of the moon's crust at an early stage in its history; and as the results of powerful radial explosions within the moon, which heaved up the crust into a circular rampart. But none of these theories is really sound.

The lunar craters look like extinct volcanoes, and volcanic they must certainly be in character: probably they were volcanoes of the type known on earth

as "quiet." There is an excellent example of this class in the island of Hawaii, known as Mauna Loa. Normally this crater is a lake of lava three miles in diameter, with a crust hard enough to walk on. But when in a state of eruption, the floor rises and cracks in all directions, while through the fissures there exudes a sea of molten lava which continues to rise until it overflows the crater walls and pours down the outside. When the disturbance subsides the level of the floor sinks and the crater gradually assumes its normal appearance. Each eruption, however, slightly enlarges the crater and adds to the height of the walls. In much the same way it is probable that the lunar craters were formed in past ages.

Recently another ingenious theory has been worked out, and is regarded by those most competent to judge as being highly probable. It assumes that the expansive gases within the moon would cause the crust to bulge at its weakest points. When the bulge has reached a certain size, depending on the tenacity of the material, it would crack at the summit or crown, the edges falling in, to be melted in the well of molten lava beneath. In this way a circular crater would be built up, continually enlarging in size until the disturbance has spent itself, while it would exhibit walls steep on the inside but gently sloping on the outside, which is exactly what is observed in the lunar ring formations. But which of these theories is the right one will probably never be certainly known.



THE TRIESNECKER CRATER.

Probably the most spectacular cleft-system on the moon. The depth of such clefts may be as much as ten miles.

If we look at the full moon through a good field-glass, or failing that examine a modern photograph of the moon, we shall find that the dominant features are extensive systems of brilliant rays radiating from certain craters. The most remarkable of these ray-systems is that associated with the crater Tycho, from which the streaks extend for enormous distances. These rays are undoubtedly the most mysterious phenomenon to be found on the moon. The most probable explanation of their nature is that they mark the position of radiative cracks formed in the moon's crust by the expansion of sub-surface material, through which cracks some crystalline substance has exuded, and spread over the surface. Another theory is that the bright streaks are deposits of salt left over from the dried-up oceans of the moon.

There are, however, true cracks in the moon's surface which are generally known as "clefts" or "rills." A vast number of these have been discovered by means of large telescopes, and they are among the most delicate features visible on the lunar surface. Probably the most spectacular cleft-system is that near the crater Triesnecker. They form a complex network covering a large area, and evidently have their origin in a small crater which must have marked the seat of the disturbance that gave rise to the cracks. The sides of these clefts are practically perpendicular and their depth must be very great, though, of course, it is impossible to determine how deep they really are. Ten miles is a probable estimate. Some critics deny that the clefts are continuous. They consider them rather as chains of minute crater-pits too close together for the telescope to separate them. Such crater-chains are to be found on the moon, notably near the crater Copernicus, but the practised observer would never confuse them with true clefts.

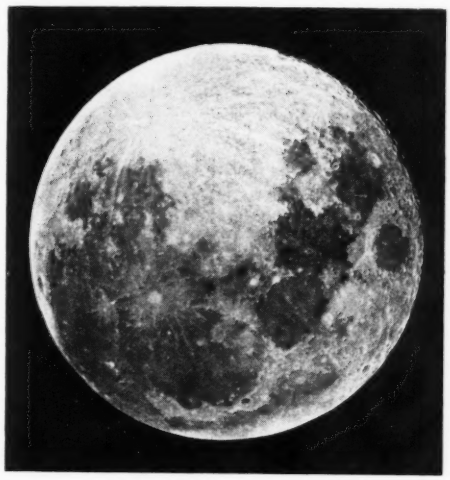
The dark areas which to the naked eye make up the "face in the full moon," and which were called "maria" or seas by the earlier astronomers, provide yet another lunar problem of the first magnitude. They are now known not to contain water, and the telescope reveals them as desert plains. It is possible, of course, that they are dry sea-beds, but this is by no means certain. Their roughly circular shapes suggests a common origin with the walled plains and craters of the moon, although their areas would seem at first sight to render such a view untenable. Why are they so much darker than the remainder of the lunar surface? That again, is a problem awaiting solution.

The question is often asked, Is there life on the moon? Or is a "man in the moon" an utter impossibility. The answer must necessarily depend on the conditions that obtain on the moon's surface. Two vitally necessary factors, at least, may be mentioned, in the absence of which life cannot exist, namely, water and air. It is practically certain that

there is no water on the moon at the present time, whatever may have been in the past. The surface of the moon as we see it is a waterless desert, though there are some who hold with Fauth, the celebrated German selenographer, that the whole lunar surface is encased in a thick shell of ice. But though water, or at any rate, water in its liquid state, is absent from the moon, careful observers have reported temporary obscurations of certain regions that could only be regarded as water vapour issuing from cracks in the crust. Others, working with exceptionally fine instruments, have observed traces of snow lurking in the crevices of certain lunar mountains where the sun's rays seldom penetrate.

It was formerly supposed that the moon possessed no atmosphere. This was concluded from the fact that when the moon passes between us and a fixed star, which happens very often, the star vanishes with startling suddenness the instant the moon's limb reaches it. If there were any appreciably dense atmosphere on the moon, it would introduce a refraction effect, causing the star to linger, as it were, on the extreme edge of the moon's disc, before finally disappearing. On the other hand, there are well-authenticated observations which tend to show that the moon does possess an atmosphere of a sort. For instance, it occasionally happens that a planet is occulted by the moon in the same way as a fixed star. In this case a dark band, parallel to the moon's edge, has been observed to cross the planet. However, this dark band may be due to some other cause, as yet unknown, as it seems much too narrow to be an effect of a possible lunar atmosphere. Then again, a prolongation of the cusps of the new moon beyond the terminator has often been observed, and this is generally regarded as a twilight effect due to an atmosphere. However that may be, what air there is on the moon must be of an extremely tenuous nature, not at all like our atmosphere.

The dense atmosphere round the earth acts as a very efficient screen from the fierce glare and heat of the sun. It also acts as a blanket, preventing the heat received from the sun during the day from being dissipated away into space during the night. On the moon, matters are very different. During the lunar day of a fortnight's duration, the surface is exposed to the unmitigated light and heat of the sun, whose rays beat down on it with a merciless intensity quite unknown on earth. In these conditions the temperature of the lunar surface rises until it becomes at least as hot as boiling water. Then, during the lunar night, for a further period of fourteen days, it is exposed to the terrible colds of outer space, compared to which our Arctic regions would be regarded as mild. With these facts in mind, it is a waste of time to discuss whether there are any men on the moon. The moon is, to all intents and purposes, a dead world.



SURFACE OF THE FULL MOON.
View showing bright radiating streaks and dark plains which present a problem of the first magnitude.

Are there any changes going on in the moon at the present time? It can be answered at once that there are, though they are by no means obvious to a casual observer. It is true that Sir William Herschel believed that he had witnessed a volcanic eruption on the moon, but it is now known that he must have been mistaken or deceived in some way. Nothing so spectacular has ever been seen since.

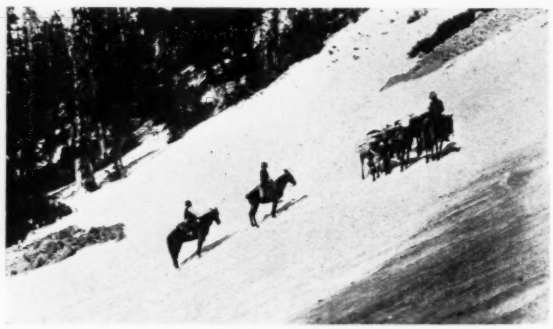
A small crater in the Mare Serenitatis, named Linné, appears to have undergone a distinct change since the last century. It was described by Beer and Madler as deep, and was about six and a half miles in diameter. However, in 1866, Schmidt, of Athens, noticed that the crater had disappeared, while its place was occupied by a whitish patch, as if the walls of the crater had collapsed. This seems to be the best-attested case of actual physical change on the moon.

Those who have devoted years of patient and assiduous study to the surface report that there are certain regions which undergo periodic changes of colour as the lunar day advances—seasonal changes, in fact, which seem to point to some kind of vegetation growing there. While there may not be men in the moon, or life in any of its higher forms, the idea is gaining ground that some low form of life, such as moss or lichen, may cling desperately to its rocky face, and that the moon is not entirely the bleak and arid desert it was formerly believed to be.

The Geological Survey of Alaska.

Under U.S. government auspices a geological survey is being continued in Alaska, where two-thirds of the ground has still to be adequately charted. A correspondent here reviews the work in this territory.

In England the term "surveyor" is generally associated with housing, but in such countries as the United States and Canada, one of the most important branches of the science is geological or mineral surveying. The work is wide and full of adventure, and in carrying out exhaustive surveys months are sometimes spent by expedition parties.



A SURVEY PARTY "ON THE TRAIL."

Under the auspices of the U.S. Government, wide areas are still being explored by the geologist, and during recent years discoveries in the mineral industries, notably in connexion with petroleum, have had noticeable effects on geological work in America. The most conspicuous result has been a great increase in the number of geologists professionally engaged on oil and mining problems.

The United States has, of course, reached that point in the utilization of many of its mineral supplies where the easily discovered deposits are known and are under development. Though the commercial world realizes the situation but dimly, the peak of production in some of the essential necessities of civilized life may have already been passed, and the technical staffs of the mineral industries are well aware that the task of finding reserves is becoming more difficult. This need has stimulated the demand for helpful information, and the aid of the geologist is increasingly sought. Further, there is a growing recognition of the value of pure research, which may throw light on the laws controlling the occurrence of the useful minerals. The geologist in commercial work is usually so busily engaged in applying known principles that he has little opportunity to develop new ones. The research institutions having geological staffs are, under these conditions, more and more expected to supply the basic data needed in the development of mineral resources. The details of small areas can often be adequately determined by the practising mining engineer, but accurate geological maps are required of larger districts and stratigraphical determinations must be made, with details of structure, paleontology, the extent of mineralization, and so forth.

For some considerable time extensive exploration work has been in progress in Alaska, to determine the degree of probability that in Arctic Alaska may be found sufficient petroleum to meet naval and other needs. After more than a quarter of a century, however, the Geological Survey has covered adequately only about a third of the territory with standard maps and reports. Of the remaining 350,000 square miles, nearly 200,000 will be surveyed as soon as funds and personnel are available. South-eastern Alaska, in addition to containing minerals of commercial value, has water-power resources that will aid in developing the mineral and forest product industries. Other important areas are those in the general vicinity of the Canadian Pacific Railway, and a belt of mountain area from 100 to 300 miles wide, stretching from the international boundary to the Arctic Ocean on the west, which is largely unsurveyed and in which there are indications of valuable mineral deposits. Larger problems relating to the different mineral resources of the territory must also be studied, but the accumulation of data has now reached a stage where the compilation of a general geological map of Alaska is warranted.

The past history of Alaska is an adventurous one. About thirty years ago Alaska was almost unknown, except to the pioneers and prospectors who had fished its teeming coasts, trapped its furs, and started small towns. With its neighbour, the Yukon, it was otherwise hardly more than a geographical curiosity—a huge unexplored block of land over three-quarters of a million square miles in size, forming the northern tip of the American continent. As far as could then be estimated, it had no very remarkable

THE ALASKA SURVEY: PACK HORSES ARE USED TO CARRY THE VARIOUS INSTRUMENTS.

resources or trading possibilities; on the contrary, it was apparently a land of perpetual winter, in many ways resembling Russia, to which it had once belonged and from which, at the Bering Strait, it was so narrowly separated. In 1896, however, the discovery of vast quantities of gold in the Klondike let loose so much sensation that overnight Alaska became the most talked-of place on earth. That feverish stampede to the north was like nothing that had ever happened before, or is likely to happen again.

Alaska is still a land of romance, its atmosphere impregnated with memories of those sad, glad days when the century was just turning over, but gold has ceased to be its principal advantage. It proved, indeed, a false hope in those many ghost-like "cities" that parade their empty shells from Dyea to Nome—but there is equally the romance of to-morrow, the discovery of other and richer resources, the development of a vigorous, prosperous, northern empire. Alaska is certainly a land of contrasts, and it is mistaken to regard it as always under winter. In summer, gorgeous vivid flower gardens are everywhere seen, for the warm Japan current which strikes Vancouver Island is deflected northward, and carries to the "Land of the Midnight Sun" the same delightful humidity that the Pacific Coast knows. And it is a land of magnificent scenery.

Geographically, Alaska can be divided roughly into three parts. First, there is the "Pandhandle"—a long, narrow ledge of land between the British Columbia boundary and the sea, running from latitude 55° to 60°, and bold, steep and craggy. Secondly, there is the huge blunt peninsula of "continental" Alaska, running from latitude 60° to 300 miles north of the Arctic circle, and measuring some 600 miles from the Yukon boundary, west to Bering Strait; and lastly, there is the long, broken fringe of the Aleutian islands.

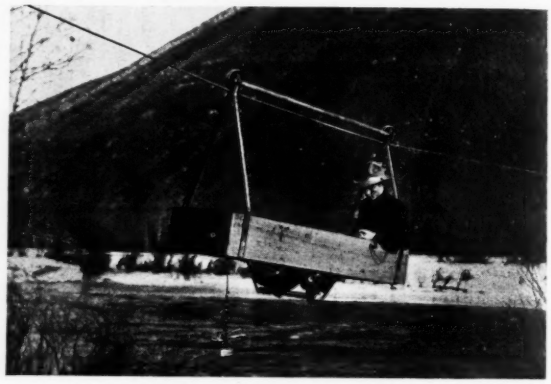
The Yukon territory can be easily confused with continental Alaska, for its topography, atmosphere, and general environment are similar; but it is separate politically, being a part of Canada and not of the United States. It lies between Alaska and the North-west Territories, and extends from the northern boundary of British Columbia to the Arctic Ocean. Alaska has an area of 591,000 square miles, and a population of about 60,000. Its territorial capital is

MAP-MAKING UNDER DIFFICULTIES.
The tripod is tied with ropes to keep it stationery while the surveyor is at work.

Juneau. The Yukon has an area of 207,000 square miles, with a population of 5,000 and territorial capital at Dawson.

The mountains that fringe the Inside Passage to Alaska form practically one range—the Coast Range. Leaving Vancouver, the mountains are, as a rule, higher on the mainland side than on Vancouver Island, averaging 3,000 to 4,000 feet in height; but towards Queen Charlotte Sound they tail off somewhat. From the other side of the Skeena River, and entering the long Alaskan "Panhandle," the altitude increases again. From Juneau north to the White Pass the range is sometimes known as the Chillkoot Range. In the extreme south-west of the international territory, where it tucks into Alaska, and lying on both sides of the international boundary, is an isolated, exceedingly lofty group of mountains known as the St. Elias Range. Mount Logan (19,539 feet) and Mount St. Elias (18,024 feet) are the highest peaks, of which the former was climbed for the first time in 1925. They are, however, very inaccessible owing to lack of transport. Mount McKinley, the highest mountain on the American continent, lies in the National Park of that name about 400 miles west of this group.

That the duties of the ground surveyor in this territory are certainly adventurous is borne out by the accompanying photographs issued by the U.S. Department of Interior. An expedition party for a geological survey such as that in Alaska, consists of a chief geologist, ten assistant geologists, four topographical engineers and assistant, a draughtsman and three clerks. At selected gauging stations the volume of water carried by the streams is measured and records of stage and other data are collected, from which the daily stream is computed. The information thus obtained is sent from the district offices to Washington, where it is prepared for publication. In this way the records from different parts of the country are made uniform, and standardization is further effected through annual conferences of the engineers.



MEASURING A RIVER'S CURRENT.
Where no bridges are available, a cable railway is slung across the river. The measuring instrument is seen hanging from the trolley, before being lowered.

Photographic Congress.

THE seventh International Congress of Photography, to be held in London from 8th to 14th July under the auspices of the Royal Photographic Society and the Commission Permanente des Congrès Internationaux de Photographie, will provide an unusually complete resumé of new developments in this science. Apart from discussions on standardization, in particular relating to kinematography and plate-testing methods considered at the previous congress in Paris, in 1925, there will be papers on foreign researches, presented through official national channels. As on former occasions, the Congress will consist of three sections, dealing with scientific and technical questions, pictorial photography and the bibliography of photography—including copyright, patents and other legal problems. In the last connexion, it is proposed to hold exhibitions of pictorial and record photography, and of historical apparatus, while there will be excursions to places of interest. Professor Sir William Pope is chairman of the executive committee of the Congress, for which application for membership (half a guinea; with copy of Proceedings, one guinea) may be made to the honorary treasurer, at 35 Russell Square, W.C.1. A full programme of arrangements will be sent to members before the opening date, and it is hoped to issue in advance, abstracts of the papers to be presented at the meetings. For the convenience of foreign members it is hoped that these will be available in French, and if possible in German. The scientific applications of photography to be discussed include spectroscopy and photomicrography, as well as astronomical, natural history, and aerial work.

"CAT'S CRADLES."

To the Editor of DISCOVERY.

SIR,

I regret to find that an error occurred in the description of the Fijian string game called *Balawa*, given in my article on "Cat's Cradles" in your April number. In the fourth stage of construction, instead of dropping the thumb and little finger loops of the *left* hand, the corresponding loops on the *right* hand are those to be released.

Without this correction the desired figure cannot be reached.

Yours sincerely,

Freetown, Sierra Leone. JAMES HORNELL.

Benn's Sixpenny Library.

The following concludes Mr. V. E. Pullin's review of the first scientific titles in this new library.

The next sub-branch of the series is concerned with science of living rather than non-living matter. The first book on our list is Dr. William J. Dakin's *Introduction to Biology*. Physiology is of necessity of the greatest interest to all of us. When it fails to interest we die. Important though it is, it is lamentable that so few people know anything at all of the working of their own bodies. The body is a highly complex and most interesting engine. Dr. Dakin explains the working of this engine from the very beginning. "Fundamentals" he calls it. He describes the structure and nutrition of that important individual, the protoplasmic cell. In his discussion on nutrition he refers, in a way that is sure to excite interest, to those important substances—now so much advertised—vitamins. There is another unit concerned in biological life which has also received some measure of popular notice, although not always very accurately described or understood. I refer to hormones. This entity, which exerts such enormous importance in reproductive activity, is discussed in an interesting manner, and its significance is properly explained. The phenomena of reproduction, growth and death are traced from the simplest organism to the most highly differentiated individuals. As an introduction to the vital subject of physiology it is difficult to imagine anything better than this book.

From biology it is but a short step to Dr. Ronald Macfie's book on *The Body*. Here human physiology is explained at quite considerable length. A lot of space is devoted to the nervous system and the functioning of the brain. Physiology is not by any means an easy subject for the layman, but Dr. Macfie has so interpreted his subject that it will be found full of the greatest interest to the general reader.

Evolution.

Professor MacBride's *Evolution* is concerned with a much more popular subject. Popular Darwinism is by no means always true Darwinism. The real meaning of, and evidence for, evolution is set out in this book with commendable clarity, and it should go far to engender a right conception of this important subject where perhaps much misapprehension existed hitherto.

The next book in the series is *The Mind and its Workings*, by Mr. C. E. M. Joad. Psychology is another frequently misunderstood word. It is sometimes associated with various kinds of occult phenomena, whereas really within certain limits it is a highly defined science. Mr. Joad's book is philosophical in design, and in execution it is moderate and well balanced. Such interesting subjects as the nature of memory and the nature of the mind are discussed in a most readable manner. The conflicting views of modern psychologists on these subjects are treated with conspicuous fairness. There is no doubt that the branch of science which seeks to explain mind activity has an irresistible fascination, and many readers will be surprised to learn how much has been done in this direction.

Psycho-Analysis.

Psycho-Analysis, by Dr. Ernest Jones—it is interesting to read an authoritative account of this subject. The limits of the usefulness of this branch of science as a therapeutic agent is not very generally understood, and our gratitude is due to Dr. Jones for the way in which he defines it. We may agree or disagree with the principles involved in this system of thought, but we cannot fail to be interested to learn exactly what is aimed at by its professors. The dominating influence of sex in all human activity may be true, but it is somewhat alarming to accept such a doctrine unless it is taught and exercised by suitably qualified practitioners. It is for this reason chiefly that we are indebted to Dr. Jones for his clear and eminently scientific method of handling this difficult question.

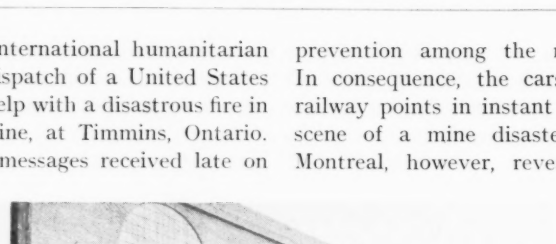
The last scientific book that we have to mention is *The Weather*, by Dr. C. E. P. Brooks. We commend this book particularly to all farmers and professors of agriculture. It is a subject that is notoriously difficult, but after reading Dr. Brooks' book the reader may be in a position to criticize the daily weather forecast, as he will certainly have a very sound knowledge of the principles upon which such forecasts are calculated.

There is very little more to be said concerning this admirable series of books. It would be an excellent thing if they found their way into every school in the country. The subjects dealt with are, as we have already said, presented in a palatable form, and for this reason they may serve to direct the attention of the young generation to matters that may very well influence the whole of their lives. Although the series is generally excellent, it is, of course, true that some of the books stand out in a class by themselves. Nevertheless, we have been so favourably impressed that it has been necessary to write this account with considerable restraint lest our enthusiasm should be too evident.

An International Rescue in a Mines Disaster.

How an American rescue train was sent to the aid of a disaster in the biggest Canadian gold mine, beating all speed records over a thousand miles journey, is a new episode in mining history that has more the character of cinema fiction. Latest discoveries in rescue apparatus were employed.*

UNIQUE in the annals of international humanitarian activities, was the recent dispatch of a United States "rescue car" and crew to help with a disastrous fire in the great Hollinger gold mine, at Timmins, Ontario. Responding to telegraphic messages received late on 10th February, a Bureau of Mines rescue car set out the same night from a remote Pennsylvania coal-mining town, and in the early morning of 12th February it arrived at the Hollinger mine, hundreds of miles north of the Canadian border. Running with special engines provided for every section of its long journey, the car was hurtled through in some hours less than is required for the fastest express trains.



THE CAR THAT MADE THE DASH TO CANADA.
No. 3 of the U.S. Bureau of Mines' fleet of ten rescue cars is the most fully equipped in the world. Kitchen and living accommodation are provided.

The first appeal received from the burning mine was hardly definite enough to enable the Bureau of Mines in Washington to determine the nature and seriousness of the emergency. It was the first time that another country had asked the Bureau for aid of this kind, and the question immediately arose as to the legality of sending the men and equipment out of the country. There was also the matter of expenditure, with little or no precedent or authorization, and it was not known whether the extent of the disaster justified an international expedition. Then the ten rescue cars of the Bureau are at all times widely scattered, being generally engaged in educational work in the remote mining regions, where rail and telegraph facilities are strictly limited. The primary purpose of the Bureau's organization is not, as sometimes imagined, the succouring of life in times of disaster, but is to give instruction in first-aid, rescue training, and accident prevention among the million miners of America. In consequence, the cars are not held at strategic railway points in instant readiness to proceed to the scene of a mine disaster. Further messages from Montreal, however, revealed the serious nature of the Hollinger fire, and sanction was at once granted by the Department of Commerce, of which the Bureau of Mines forms a part.

In the meantime, it had to be decided which of the ten widely scattered rescue cars was the most suitable for this unusual service, a problem involving serious consideration. Fighting mine fires is highly specialized work, the procedure in combatting a metal-mine fire, for instance, being quite different from that required for fighting a coal mine fire. Car "No. 3," which was at Jenners, Pennsylvania, a small coal-mining town some seventy-five miles south of Pittsburgh, was eventually selected. Not only is this the Bureau's "crack" mine-rescue car, having only recently been built and embodying the latest equipment, but it happened to be situated comparatively near to the Pittsburgh experiment station, where ample supplies of fire apparatus were available.

The next task was to get the car moving northward. Jenners is not on the main line of a great railway, and country telephone facilities after nightfall are not those of a metropolis. Several long-distance calls and various telegraphic messages sent from Washington and from Pittsburgh failed to elicit any response. As the hours wore on, the situation looked bad, when by a fortunate coincidence the foreman-miner in charge of the car happened to telephone from elsewhere to the Pittsburgh station, in regard to routine matters. The urgent message was thus delivered. It was not

* Here abstracted from the U.S. Bureau of Mines report, and illustrated with photographs specially sent to *Discovery* from Washington.

easy at midnight to get an engine for the mine-rescue car, at the moment reposing on a little-used side-line in the Appalachian hills, but soon the special train was rumbling down towards the junction of Somerset, some twelve miles away. Next the car was switched to another short line for a run of nine miles, and eventually to the main line, where it was attached to a passenger train going to Pittsburgh. Here it was manned by an expert staff under Mr. Daniel Harrington, chief engineer of the Safety Division, and extra equipment was hastily loaded.

Fifteen sets of oxygen-breathing apparatus were carried, with gas masks, and carbon monoxide "self-rescuers." In addition to flame safety lamps there were also electric flash-lights and cap-lamps; ten cylinders of oxygen; four canaries; chemical detectors for carbon monoxide; and gas-analysis apparatus. Each set of breathing apparatus is capable of supplying the wearer with oxygen for at least two hours in any smoke or gaseous atmosphere. The little self-rescuers, worn suspended from the belt, will filter poisonous fumes from air and are exceedingly useful in emergency. The gas masks are considered to give protection against more deadly gases than any other type of mask, but do not provide oxygen—hence they cannot be worn, like the breathing apparatus, in atmospheres deficient in oxygen. The carbon monoxide detectors are ingenious devices which warn of the presence of this gas through change in colour of iodine pentoxide. The gas-analysis apparatus enables the observer to determine from an air sample whether fire may be raging in a particular area of the mine or whether poisonous carbon monoxide or inflammable methane is prevalent. Each oxygen cylinder contained ten cubic feet of oxygen under approximately 2,000 pounds pressure.

MINE EXPLORING AFTER A DISASTER.
The oxygen apparatus carried on the back provides two hours breathing supply. Other devices seen include carbon monoxide detectors and electric cap-lamps.

In addition to mine-safety equipment, Car No. 3 is provided with numerous devices, such as electric charging apparatus for use with the cap-lamps. There are also complete electric light and water systems; an oxygen pump and electrical refrigerator; besides a demonstration room, a bathroom, and dining and kitchen arrangements. Beneath the car are specially constructed compartments for the storage of stretchers, oxygen cylinders, and other equipment.

At 9.14 on the morning of 11th February, the car was headed northward for Buffalo, over the Pennsylvania Co.'s line from Pittsburgh. American and Canadian railway authorities co-operated in the emergency, and a clear right-of-way was provided, which allowed the train to reach Buffalo at 3 p.m. Not many minutes later it was heading over the Canadian National line for Toronto, and at 6.20 a.m. on 12th February it drew up at Timmins, 485 miles north of Toronto. All previous time records had been beaten. It was the fastest time ever made between Pittsburgh and Buffalo, being two hours less than the best passenger schedule, while an average speed of 47 miles an hour was maintained for the 1,000 mile run. Speeds of 70 miles an hour and more were attained, although long stretches of track on the northern part of the run consisted of snake-like curves, and four feet of snow lay packed through the northern forests. Telegraphic messages to Buffalo, Toronto, and other junction points had provided special engines in instant readiness. At the international boundary, custom inspection was waived, and everyone throughout accelerated the long northward flight of the train. The engine driver over the last northern division stuck valiantly to his post, although nearly frozen when the special train was at last brought to a standstill.

Arrived at their destination, the American volunteers did not immediately don their apparatus and descend into the burning gold mine, as modern mine fires require other methods. Unlike a burning building, on which high-pressure hoses are immediately applied, a fire in a mine involves knowledge of the lay-out of its devious passages. There were nearly 100 miles of underground workings in the Hollinger gold mine, and nothing was to be gained by a headlong plunge into its smoking depths. The efforts of the mine staff aided by volunteers had already rescued thirteen of the entombed men at the outbreak of the fire, but

lack of oxygen-breathing apparatus, such as was carried by the Bureau car, had prevented a more thorough exploration of the mine. There was scant hope that any of the other missing men would be found alive.

At 8 o'clock on Sunday morning the American engineers went underground. The passages of the smouldering mine were filled near the fire with volumes of smoke, and while with their oxygen apparatus the men could penetrate this dense atmosphere, they were practically helpless to do more than grope their way round. The problem therefore admitted of but one solution—to clear the mine atmosphere in the shortest possible time. To this end, a method long used successfully in coal mine fires was brought into play, namely, regulation of the air currents by means of canvas screens placed at strategic points. Air compressors forced the pure surface atmosphere into every crevice of the underground passages, displacing the smoke, and for hours the rescue men advanced towards the smouldering fire area, their general objective. Special consideration had also to be given to the powder magazine, situated barely 300 feet from the fire centre. This last was reached after ten hours work, and streams of water from 1,200 feet of hose were then directed on the fire. By midnight, in places where it had been impossible to see objects a foot or so away, the bodies of forty unfortunate victims were being removed in fresh air, but fire work had to be carried on continuously until early on Tuesday before it was completed.

On the return journey, made leisurely by passenger train, the American rescue party had a rousing send-off, and at Toronto their car was visited by more than 2,000 people, including members of the Canadian Institute of Mining and Metallurgy. A reception was held later in the Ontario Parliament Building, where the Premier, Mr. Howard Ferguson, expressed Canada's gratefulness for the help that had been extended by her neighbour to the south. "I hope," the Ontario Minister of Mines afterwards wrote, "that cordial relations may long exist as a bond between your people and ours, and between the mining fraternity of the United States and Canada."

Book Reviews.

POPULAR PSYCHOLOGY.

The Mastery of Mind. By J. C. FLOWER. (Lutterworth. 5s.).
That Mind of Yours. By D. B. LEARY. (Lippincott. 6s.).
Making up One's Mind. By W. ROBERTS. (Daniel. 2s.).

There used to be a branch of philosophy called ethics; its object was to define the meaning of the terms right and wrong, and to indicate the nature of the good life. It was even claimed by some that it helped one to live the good life. Then came psychology; at first rather an arid and technical affair, which compiled lists of instincts as if they were glands, it seemed to have no relation to life as we knew it. Presently, however, under the influence of psycho-analysis it began to concern itself with practical problems, and to lay down rules for successful living. In this guise it is called "the new psychology," and, as morality becomes increasingly unfashionable, so that to be called virtuous is almost a term of reproach, it is coming more and more to supersede the old-fashioned ethics.

The three books mentioned at the head of this review are cases in point. They are concerned not only to explain psychology, but to explain it to the advantage of the reader; they propose, in other words, to make him better, or rather they encourage him to utilize psychology in order to make himself better. These books, then, are in every sense of the word popular. Mr. Flower's is written in dialogue form, while in Mr. Roberts' a breezy psychologist discourses on a variety of objects such as chairs, wild cats, and the soul, to an entranced family circle. His object is, it appears, to enable one to avoid vacillation and to arrive rapidly at firm decisions by explaining what the mind is and what making it up involves.

The object of Mr. Flower's book is more general, but no less laudable. It is to help us to master our mental processes, and so to become more effective as human beings. In order to achieve mastery it is necessary to know what one proposes to master, hence the importance of psychology. Mr. Leary has observed that thinking is not enough to make us happy. On the contrary, the happiest organisms, for example, cabbages or pigs, are probably those that think the least, while among so-called thinking beings, the intellectual, as everybody knows, is morbid and exacting, given to making impossible demands of life and irritating his friends. Hence, while thinking should not be abandoned, we must, according to Mr. Leary, insist on obtaining the right material to do our thinking with, the right material being apparently not an isolated figment called the reason but "the emotions, the physical condition, the daily behaviour, and all those other aspects of human beings which modern psychology at last has come to emphasize." The organism, that is to say, is a unity or ought to be; it is as a unity that it should do its thinking, and it is the business of psychology to tell it how to become one.

Now I do not wish to criticize these books on technical grounds—Mr. Flower's, as a matter of fact, is exceedingly good, his discussion of the will, for instance, being at once more intelligent and intelligible than the reader is likely to find in more imposing works on psychology—but I do feel sceptical about the existence of these alleged practical benefits of studying psychology, which all three writers seem to expect. There are two things in particular I should like to say about them.

First, is it in fact true that an acquaintance with the so-called practical implications of the new psychology helps us in the business of living? If we are abnormal or eccentric, no doubt it is; but even then we were better with a trained psycho-analyst than trying to cultivate will power or adjustment by ourselves. For the rest, one may well ask whether psychologists are them-

selves particularly noticeable for efficiency in practical affairs and mastery of the art of living. I think it is clear that they are not. They are not more successful as husbands or as citizens than their neighbours; they are just as likely to lose their tempers when they break a bootlace or to swear when they miss a train. Yet it is to be presumed that they have mastered all the hints on living that the new psychology, as expounded by them, has to offer.

In the second place, the new psychology is something of a hypocrite. It sets out to examine and to describe in an impartial and scientific spirit the working of the human personality. It is not interested in moral problems, and duty is for it a *démodé* word. Its concern is not with what ought to be but with what is. "To look at human beings psychologically," says Mr. Leary, "is to look at them without pride or prejudice; it is," he continues optimistically, "to look at them as they are." But having kicked ethics ostentatiously down the front steps, it proceeds to introduce them surreptitiously through the back door. I say surreptitiously because while, as we have seen, making use of old-fashioned ethical notions such as that of betterment, it uses new words to describe them, words which have a pseudo-scientific flavour. It does not use the word virtuous, it substitutes "properly intergrated"; it does not say "a good character" but a "personality well adjusted to its environment." And sometimes we come across a phrase which fairly gives the game away. "Psychology aims at such knowledge of human nature that it can mould, change, *better* that human nature," says Mr. Leary. Now what does "better" mean? More adjusted to environment, perhaps. But what is the good of being adjusted to your environment, unless something of value comes of it, and something of value reintroduces the nature of "good"?

I conclude that if we are to deal in "goods" and embark in moral exhortation, then we had better make a clean breast of it and have recourse to ethics or religion; psychology should keep to its task of analysis and description, and not offer itself as a substitute for either. Yet this is what the new psychology too often seems to do.

C. E. M. JOAD.

PREHISTORIC CULTURE.

The Age of the Gods. By CHRISTOPHER DAWSON. (John Murray. 18s.).

Although anthropology, like other sciences, is being more and more sub-divided among specialists, in one branch, namely, archaeology, the view has broadened. In details it is still and always will be a highly specialized study; but the student who seeks to interpret the detail, and to trace the growth of culture in its broader outline, can no longer expect to rely solely upon the data of the archaeologist in the narrower sense, or even upon the comparisons with primitive material culture with which a previous generation was content.

It is inevitable that Mr. Dawson's book should suggest some such reflexion, for it is an attempt to reconstruct the origin and growth of cultures in prehistoric Europe and Western Asia from the beginnings down to the Iron Age broadly in the light of anthropology and ethnology, to reconstitute the religious beliefs and the social organization at different stages in the light of social anthropology, of the comparative study of religion and of survivals in folklore. Probably most readers will already be familiar with the interpretation of palaeolithic cave paintings by primitive conceptions of sympathetic magic. They will perhaps be less familiar with the evidence to be deduced from animal worship and totemism and the conception of the Mother Goddess, of which the beginnings are to be seen in the statuettes of palaeolithic man but find a wider extension with the expansion of the fertility cult in the agricultural Neolithic Age. It is, however, in dealing with Mesopotamia and its city states and with early Egypt that Mr. Dawson's method of treatment is most illuminating. The relation of Irish legend to the impact of Iberian culture on Ireland, gives rise to some remarkable correspondences such as that of the coming of the children of Miled from Asia Minor by way of Crete to Spain, and thence to Ireland, with the period of expansion of the megalithic culture. But, as the author notes, they must be accepted with caution, in view of the way in which geographical terms in popular folklore have obviously been "worked over" in the hazy light of the fragments of monkish knowledge which filtered through to the people.

Taken as a whole, Mr. Dawson's book makes an admirable guide to that background of knowledge of the growth and character of prehistoric and early historic culture which are an essential to perspective in the application of archaeological discovery.

E. N. FALLAIZE.

MICROSCOPIC ANIMALS.

Hunting under the Microscope. By SIR ARTHUR E. SHIPLEY, G.B.E., F.R.S. Edited by C. F. A. PANTIN, M.A., Physiologist to the Marine Biological Station, Plymouth. (Ernest Benn Ltd. 8s. 6d.).

As a preliminary note in *Discovery* (February) has indicated, this delightful little book consists of a series of essays by the late Master of Christ's College, first published in its columns and now collected and arranged by one of his most brilliant pupils Mr. C. F. Pantin, who also contributes a valuable introduction.

The object of the book is to interest the average amateur in the creatures of microscopic size which he is likely to meet with in examining the water from fresh-water pools, gutters, and ponds. But the insight and genius of the author are displayed in the way in which he makes each object illustrate an important point in biological science. Thus the very first chapter on "Suspended animation" raises the fundamental question "What is Life?" "Life," says Sir Arthur, "is difficult if not impossible to define, but living beings have certain definite attributes, such as breathing, feeding, moving, and so on." Yet, strange to say, all these attributes can cease and yet life may persist as a potentiality, as is shown by small creatures such as the Tardigrada (Bear-animalcules) and Rotifers (Wheel-animalcules), which can dry up and become motionless and almost indistinguishable from particles of dust, and yet revive and become active when moistened with water.

The same power in lesser degree is exhibited by frogs, which bury themselves beneath stones in winter, by reptiles and even by mammals such as the dormouse and the racoon, which retire to holes during the winter and enter on a month-long sleep. Nay, as Sir Arthur hints, this power may not be wanting to the human race itself, and he recounts the thrilling story of a Fakir who allowed himself to be buried alive, and who when dug up and examined exhibited no trace of breathing or of heart beat, and yet who was completely revived in a few minutes. Life cannot be defined because to define is to compare, and

there is nothing like it with which we could compare it. Life works through and uses—in a word "regulates"—ordinary matter and energy, but what "it" itself is remains a mystery. In dealing with the green pond-flagellate Euglena, the author discusses the problem "What is the difference between a plant and an animal?" Euglena is green and uses sunlight to split up carbon dioxide like a plant, but it moves like an animal, and has even got a tiny gullet through which it can take occasional meals of solid food. Is Euglena an animal trying to become a plant or a plant trying to become an animal? Sir Arthur Shipley concludes that it is an organism which has not yet made up its mind as to which it intends to be, and that in the Flagellata we reach the seed bed from which both animals and plants have sprung.

In the Slipper-animalcule (Paramecium) we can observe a process of "conjugation" which seems to be the simplest form of sexual union; the author unmasks the real meaning of sex when he points out that such a union between two individuals coming from two different strains is absolutely necessary to maintain the vitality of a culture of Paramecium. The excellences of one strain compensate for the defects of another. In the case of the green sphere Volvox, which is made up of a number of flagellata joined together by protoplasmic cords, the first beginning of definite male and female reproductive cells can be seen.

Enough has been said to show how Sir Arthur Shipley "points a moral and adorns the tale" with reference to each of the minute creatures which he describes. We have no desire to "spoil" the book for its readers by giving away too many of its good things in a review. But the concluding essay differs from all the rest in being biographical; it is an account of the autobiography of Sir Ronald Ross, K.C.B., F.R.S. (whom God preserve!), the discoverer of the parasite of malaria. In this account Sir Arthur Shipley stresses the enormous importance of Ross's discovery for mankind—the long toil which was necessary to accomplish this end, and the official inertia against which Ross had to battle, and the small reward which he received for his labours. Malaria, which formerly made the tropics a white man's graveyard, became capable of control, and it was possible in certain areas to eliminate it altogether. Amongst natives of India too slothful or ignorant to exercise that control it still remains the greatest menace to human life. When the reward meted out to the scientific discoverer is compared with that bestowed on a successful general, or on a very moderately successful statesman on his retirement, it is obvious that mankind has still a considerable distance to go in adjudging the merits of its benefactors.

E. W. MacBride.

MIND AND COLOUR.

Coloured Thinking, and other Studies in Science and Literature. By Professor D. F. Fraser-Harris, M.D., D.Sc. (Routledge. 5*s*.).

This is a collection of interesting papers on various subjects. Though written in a "popular" manner, they are full of thought, often original, and always tersely and pointedly expressed,

The essay which gives its name to the book treats of the curious phenomenon named psychochromaesthia, *i.e.*, the association, in many people's minds, of concepts with colours. For instance, the days of the week may be thought of as differently coloured—say, Tuesdays always green—these coloured concepts being named "psychochromes." The author rightly distinguishes between these and synthaesia or coupled sensations, whose commonest form is a mental image of a colour, produced by hearing music, and changing either with the note or with the key, or else with the voice or instrument. Professor Fraser-Harris says there is "method in this madness," but the "sound-photisms" mentioned by him appear somewhat chaotic.

There seems, however, reason to believe that "coloured hearing" most often connects colours and sounds with regard to their respective wave-lengths. Thus, to many—Raff and Monsieur Lavignac (I quote from Mr. Klein's book "Colour-Music") may be cited as examples—the flute's notes, necessarily high-pitched, recall the colour blue; the oboe's (slightly lower) green; and brass instruments red. Locke's blind man, who called the trumpet's notes scarlet, was surely a typical case of synaesthesia, though Professor Fraser-Harris quotes his thought as a "psychochrome." Dr. Stelzner's case (also quoted), in which speech appeared coloured, and whispering—usually a monotone—non-chromatic, is likewise of great interest as a light-and-sound analogy. But, in the case of many "photisms," such as Baudelaire's, who said that musk-odour reminded him of scarlet and gold—surely owing to the flower's colour—and also of most psychochromes, M. Peillaube's suggestion is probably correct, namely, that they are cases of two sensations with an intermediate subconscious link.

One central idea, the correlation of science with other intellectual, ethical, and emotional activities, runs through most of the other studies in this admirable book.

Mary Barne.

PIKE FISHING.

The Pike Fisher. By Edward Spence, K.C. (A. C. Black. 6*s*.).

Reviewed by Sir George Aston.

"Why go a-fishing? When I tell my friends that I put back into the water almost every pike caught by me, the ladies, and most of the men, say, 'How silly,' and 'why do you go fishing?' and to this the humble and decided answer is that I go fishing not for pike but for pleasure." So writes Mr. Edward Spence in "The Pike Fisher." We can put his view alongside that of Lord Grey of Fallodon, when, in addressing the Harvard Union, he said, "If you don't like fishing, don't fish," and added thereto that if his hearers were to be on a parallel with himself they must find some recreation in which they found as much pleasure as he found in fishing, especially with the fly for trout and salmon.

Mr. Spence has done a good service to anglers in describing to them a sport that can be enjoyed all the year round, without the limitations of season (and cost) that attaches to the pursuit of what used to be called "game" fish. Why pike have never been included in that category no one who has fished for them with tackle of the same strength, in relation to weight, that one uses for trout and same, is able to understand, "What can be expected from a fish dragged by a weaver's beam connected with big hooks swallowed down to its stomach!"

Although the author maintains that he fishes for pleasure and not for pike, he confesses that he fishes for them (the pike) carefully and thoughtfully, and that he has caught a large number of them. Like all books that are written by past masters of the subjects with which they deal, this one on pike fishing makes most fascinating reading. It teems with good advice, without a trace of the patronizing style sometimes affected by expert anglers who assume that all readers are what in games of skill would be called "rabbits."

Of all methods of taking pike (and he describes all with any element of sport in them), Mr. Spence evidently prefers spinning for them. "The necessity for skill in spinning adds to the pleasure of doing it, and in my opinion nothing is worth doing at all that is not worth doing well"; and again, "a competent spinner will get far more runs than a live-baiter. He must, however, be sufficiently skilful to cast a bait on to a billiards table, fore-handed or back-handed, at twenty to thirty yards on some occasions, or his ascendency may not be noticeable."

Of the two methods of spinning, casting from the reel or from a coil of line on the bank or in a boat, he much prefers reel-casting, and he gives convincing reasons for his preference. His book is packed with matter worth reading, both by the expert and by the tyro. He gives the results of his experience to both. There are few who have nothing and many who have much to learn from them. Whether they will follow his practice of returning all his captures to the water, instead of packing them off to vendors (in the East End of London, for instance, where there is a great demand for them as human diet), is a question for themselves. For myself, I shall take the first opportunity that presents itself of seeing Slapton Lea again, preferably in July, when the sea-beach is gay with yellow sea-poppies and the borders of the sea with viper's bugloss. I am not at all likely to rival his record of pike taken from that delectable water (and returned thereto).

G. G. Aston.

TUBERCULOSIS REASEARCH.

A Study in Tubercle Virus, Polymorphism, and the treatment of Tuberculosis and Lupus with Oleum Allii. By William C. Minchin, M.D. (Bailliere, Tindall & Cox. 25*s*.).

In 1907 Professor Hans Much drew attention to the presence of certain granules in body fluids infected with tuberculosis, and, as the result of innoculation experiments, came to the conclusion that these granules (which are now known as "Much Granules") represented a stage in the life-history of the tubercle bacillus and were able, by themselves, to cause the disease. Dr. Minchin has developed Professor Much's theory by suggesting that the granules (which, in their smallest form, pass through the Chamberland filter), are the immediate cause of tuberculosis, that they should be classified as anaerobic yeasts, and that the tubercle bacillus represents a comparatively harmless stage in the life-history of a polymorphous organism.

There is nothing inherently improbable in Dr. Minchin's theory, but it cannot be said that the facts upon which it is based are wholly adequate to support it, for the evidence obtained by the author is entirely morphological and the only control experiment carried out, which revealed the presence of the yeast-like bodies in a filtrate of cancerous material does not, in itself, strengthen the theory.

In this (third) edition of the book the yeasts are illustrated by micro-photographs taken at the enormous magnification of x 4000 by means of the "Davon Super Microscope," and are probably the first examples to be published of work with this instrument, which enlarges our field of research. The photographs show structures which are very like yeasts, but their structure is not sufficiently definite to enable us to rule out altogether the possibility that we may be dealing with minute masses of inert colloid material or with dead bacteria in process of solution.

The second part of Dr. Minchin's book is devoted to advocating the use of garlic oil in the treatment of tuberculosis. This treatment has been used from almost the beginning of medicine to the present day, and Dr. Minchin attributes the common failure in obtaining consistently good results to the neglect of surgical measures, which are often necessary in order to expose the site of the disease to the antiseptic action of the garlic oil.

Purely morphological evidence is bound to be unsatisfactory in dealing with bacteria and other micro-fungi whose structural differentiation is extremely slight, but it would be a pity if equivocal appearances which are difficult to interpret should deter microscopists from following up Dr. Minchin's work and supplementing experimental methods, in this and other departments of bacteriology, by means of high-powered instruments.

F. A. Hampton.

THE PRE-WAR MIND.

The Pre-War Mind in Great Britain. By C. E. Playne. (Allen & Unwin. 16*s*.).

This work is a sincere and painstaking attempt to analyse the mind or mentality of the British public before the war. It is an interesting book, although there are some technical blemishes which the author should avoid in subsequent works. The text would benefit from condensation. The numerous quotations of whole paragraphs from contemporary writers give the book a patch-work appearance in places, and some of the quotations do not add much to what the author has already said. Contemporary works are sometimes cited without it being said who wrote them. There is occasionally an atmosphere of scissors and paste.

On the other hand, credit must be given to the author for the wide reading and earnest research which has gone to the making of the book, and to the effort which the author has made to appreciate the point of view of parties, classes, and individuals with whom she is clearly out of sympathy. The style of the book is simple and clear, if a little monotonous; towards the end of the book, however, the style greatly improves, and in certain pages is at high tension.

Some of the best things which are in the book are on the subject of nationalism. The author considers it, with fair show of reason, as "the particular passion which infatuates the world." A remarkable development which has taken place in this passion is that it is no longer represented as conducive to the general well-being; it is sheer group-egoism. The author thinks that the essence of nationalism is the crushing out of individualism; yet she goes on to state, somewhat inconsistently, that the nationalism of Great Britain did not press out individuality. Nationalism in Great Britain developed a high sense of duty. "The fact of the existence of the Empire evokes the Briton's imagination like an epic!"

For her distinctly unfavourable picture of England before the war, and for her comments upon it, the writer of the book relies on authors such as Wilfred Scawen Blunt, H. G. Wells, and G. Lowes Dickinson. Six pages are devoted to an analysis of Wells' novel "Tono Bungay." Belloc's "Emmanuel Burden" is also referred to at considerable length as an authority. *Fin de Siècle* pessimism is repeatedly described as if it were at the core of British pre-war society. The very interesting chapter on panics and the press does not give the other side of the shield—the influence, for instance, of such a journal as the *Spectator* in its attitude towards foreign affairs. The chapter on the teaching of militarism (and also of "navalism," as the author envisages this), is a careful and

informing summary of the views of certain publicists. It is a valuable exposition, but the militarist writers stand forth perhaps in a little too high relief; they were not the only people who were engaged in educating the British public in contemporary history and foreign affairs. The account of the Boer question and the Boer War, although not pleasant reading, is probably not unfair. On the other hand, in the prominence given to the impressive and fervid writings of J. A. Cramb, the author has forgotten that Cramb was practically unknown before 1914, and was only really discovered after the Great War had broken out; while Houston Stewart Chamberlain, with whom Cramb is compared, was quite a national, indeed a European figure, for about ten years before the war.

"The Pre-War Mind in Great Britain" is an interesting, stimulating, well-informed, but not exhaustive work. It is very well worth reading. Although the dark tones are (in the opinion of the reviewer) unduly emphasized, the book is nevertheless a really useful contribution to pre-war history.

R. B. MOWAT.

ANCIENT EGYPT.

The Nile and Egyptian Civilization. By ALEXANDRE MORET. (Kegan Paul. 25s.).

The English series known as "The History of Civilization," to which the present book is a recent addition, originated in a similar French series, *L'Evolution de l'Humanité*, and automatically incorporates by translation any book in the latter, although several independent volumes in English have been contributed to it. Egypt was dealt with by Professor Moret for the French series; there was therefore no place for an English writer in the other. But if we question the adequacy of the French genius to present the meaning of Ancient Egyptian history to English people, we cannot cavil at the choice of M. Moret for his part in *L'Evolution de l'Humanité*. He is the ripest and most prolific of living French Egyptologists; and in favour of his suitability for English readers, it may be recalled that he was invited to give the Frazer Lecture at Oxford in 1926.* But there lies the clue to a serious criticism of the book under review.

The Frazer Lecture, as the name suggests, is essentially anthropological in content; and this side of Egyptian studies has always been nearest to the heart of M. Moret. Indeed, he is far more an anthropologist than an historian, and since the further back one goes in Egyptian history the more purely anthropological the material for study becomes, he has tended to specialize in the earlier period at the expense of the later. This tendency is strongly marked in *The Nile and Egyptian Civilization*. Nearly a half of the whole book is taken up with the origins of Egyptian civilization, the history of the earliest separate states, and the evolution of the united kingship, together with an account of the national culture under this despotic monarchy. Yet the "sources" for this period, of a little less than 2,000 years, are probably less than we have from any single century between 1500 and 500 B.C., during which time Egyptian civilization reached its highest point and was of the greatest importance in world-history. During this time we have several proved chronological equations with external events, while for the earlier period Egyptologists are still at variance as to the main dates in the history, though able to compute with certainty the length of many of the kings' reigns. Again, it is not till we reach the New Kingdom, from about 1600 B.C. onwards, that we have sufficient written documents to interpret closely the archaeological evidence, which is practically our only guide in the Old Kingdom and earlier periods to the life of the people. In the opinion of the reviewer the proportions of the book are wrongly conceived for its place in this series. To take a concrete example: the lengthy theorizing as to the nature of what M. Moret calls the Social Revolution in the First Intermediate Period, for which the evidence mainly consists in the absence or destruction of monuments and in a very few not easily intelligible documents of a semi-philosophical nature, might well have been shortened to make room for an account of the intimately documented social disorders and strikes of the XXth Dynasty, of which no mention is made at all. Even in his special field M. Moret is not impeccable, and one is surprised that he should have put forward (p. 147) the old translation "Good Harbour" for *mennefer*, the Egyptian name of Memphis. He does not seem to realize that the city, or rather the new quarter of the city, took this name from the Pyramid of Pepi I (rather than *vice versa*), and he is almost certainly wrong in assuming that it did not become the capital till that Pharaoh's reign. The book should be read with caution by laymen; but so erudite a scholar as M. Moret has always something new for those who can check him.

S. R. K. GLANVILLE.

* The substance of this lecture was published by M. Moret in 1927 in *La Mise à Mort du Dieu en Egypte*.

WIRELESS AND EDUCATION.

New Ventures in Broadcasting: A Study in Adult Education. (British Broadcasting Corporation. 1s.).

Owing to the series of articles on broadcasting problems recently contributed by the Manchester Station Director of the B.B.C., readers of *Discovery* will find much of interest in this report, issued by a committee of which Sir Henry Hadow was chairman. Among the chief recommendations it is pointed out that while the provision of recreation and entertainment has been one of the main functions of broadcasting, it is impossible to draw a hard and fast line between recreation and education. To many recreation includes music and drama, also the general talks and debates which keep them in touch with current thought and affairs. This is, in fact, an important form of adult education, but a much larger proportion of listeners than is commonly supposed have particular interests to which special items could make an appeal. The evidence shows that broadcasting could also provide talks which would be welcomed by large sections of the community having their own special interests, such as farmers, housewives and students.

Such provision is dependent for its development on the policy of alternative programmes, which will give a choice of items to all listeners. Alternative programmes should become fully available with the execution of the scheme of regional stations. It is suggested that the most satisfactory method of providing a regular educational service would be to set aside the whole or the main part of one wave-length capable of covering the whole country to a special service of lectures, music, etc. Until this proves practicable, a definite proportion of time in general programmes should be allotted to formal education.

The cost of these and many other developments outlined in the report should, in the Committee's view, be met out of that part of the revenue from licences which is at present retained by the Postmaster-General, over and above the costs of collection and administration.

J. A. B.